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ABSTRACT

This report is intended to serve as a resource for the development of management and instructional guidelines for computer-based education (CBE). Although the data in it were gathered from PLATO projects only, they represent projects which varied widely in target populations (elementary through professional students), subject matter content, type of implementation, and size and scope. Critical incidents are defined in terms of four criteria. Then, more than 125 case histories of critical incidents are documented. They are organized by topics which will serve as a taxonomy of matters or issues critical during project development. The report includes summaries and analyses of the processes and procedures and their subsequent effects. CBE was implemented most smoothly when there was a conscious effort to develop good relations with instructors and administrators. Successful projects were those which had initial plans for procedures, organization, objectives, and evaluation. Evaluation was essential, throughout lesson development as well as after lesson completion. Successful staff members were those whose expertise was not limited to a single area. (Author)

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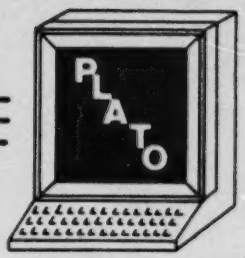


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# CRITICAL INCIDENTS IN THE EVOLUTION OF PLATO® PROJECTS

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# CRITICAL INCIDENTS IN THE EVOLUTION OF PLATO PROJECTS

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## Abstract

This report is intended to serve as a resource for the development of management and instructional guidelines for computer-based education (CBE). Although the data in it were gathered from PLATO projects only, they represent projects which varied widely in target populations (elementary through professional students), subject matter content, type of implementation, and size and scope. Therefore, it is expected that the report will be useful to developers of CBE in general, and not only to PLATO users.

Critical incidents are defined in terms of four criteria. Then more than 125 case histories of critical incidents are documented. They are organized by topics, rather than projects, which in effect will serve as a taxonomy of matters or issues which are critical during project development. The report also includes summaries and analyses of the processes and procedures and their subsequent effects.

Just a few conclusions will be given here. CBE was implemented most smoothly when there was a conscious effort to develop good relations with instructors and administrators. Successful projects were those which had initial plans for such matters as project procedures, organization, objectives and evaluation. Directors who planned contingencies, in case of failure to meet goals, increased the probability of the effectiveness of their projects. Evaluation was essential, throughout lesson development as well as after lesson completion. Many models of staff organization were noted, but there was no single best model for lesson development. Successful staff members were those whose expertise was not limited to a single area, such as programming, but who had breadth in many areas including teaching in an interactive environment.

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# Chapter 1

# INTRODUCTION

## A. Background and Rationale

PLATO is a relatively new technology (cf. Lyman, 1975), as is all computer-based education (CBE). When PLATO III, the first classroom-oriented version of the system, was introduced, the major educational efforts were exploratory and evolutionary. Directors of these early projects had to formulate plans without the benefit of other people's experience. This was due to the fact that CBE, and the PLATO III system in particular, was a novel and unique medium. Previous research in related areas such as programmed instruction and curriculum development was an inadequate source of information. Project directors tended to try out ideas in order to learn from experience. Sometimes, they shared the knowledge gained with other projects. For the most part this information was not recorded.

With the advent of the PLATO IV system a few years later, the system's capability expanded to handling hundreds of terminals simultaneously. Directors of new and larger projects had to make decisions not only about instructional design, but also about project management and organization. The new dimensions of CBE made it necessary to revise old concepts and sometimes even to develop new procedures. Directors could not anticipate all aspects of planning that would be necessary, and there were scant resources to guide them. Unlike other CBE projects (cf. Faust, 1974) each group using PLATO made its own decisions about organization, procedures, staff selection, lesson design, and evaluation. The groups varied widely in size, setting, and educational level. As knowledge and experience accumulated, staff members of each group made modifications or even complete revisions of one or more aspects of their work.

Sometimes, groups who were working under different circumstances came to similar conclusions about effective ways to reorganize or to improve some aspect of their project. For example, two projects that were very different in size, scope, and target population found that the same organizational structure met their needs. Sometimes, however, when confronted with similar decisions, the various groups chose different alternatives because of their particular circumstances. For example, some groups decided to adapt available curricular materials to the CBE system, whereas others developed new curricula. What was a good idea for one project was not necessarily considered to be a good idea for another.

The sum total of this experience can provide a valuable data base for guiding the development of many aspects of future CBE projects. Specific documentation of circumstances preceding and surrounding these incidents and decisions is essential so that the consequences may be understood in proper context. This kind of information has not been generally available. Although most projects have provided reports and summaries of their activities, these have varied considerably. They include such materials as catalogs of lessons, data on lesson usage, summaries of student performance, and comparison to control groups. Most are summative evaluations, giving little or no formative evaluation data (i.e., information about the evolution of project processes and procedures). Those reports which do include some of this information tend to be incomplete. They are prone to overlook and omit decisions and events which produced negative results. In some situations, where there was a complete turnover of personnel, the report writers tend to include little or no information about the earlier phase of the project.

Outside evaluators have written about some aspects of project development, but these are limited to their particular focus. House (1973) provided extensive process documentation about one implementation effort but necessarily discussed events that served to illuminate the author's topic, the politics of innovation in education. Similarly, Mahler and his colleagues (1976) documented PLATO courseware development, but the information is general and lacks the detail that would be needed for developing guidelines for the future.

## B. Purpose

The purpose of this report is to provide a broad-based set of case histories and decisions that were observed to have specific effects or long-term impact on the smoothness of project implementation. These incidents are intended to provide a data base for developing guidelines for future CBE projects in general and PLATO projects in particular. It is also intended to serve as a first approximation to a taxonomy of factors that should be considered in project management and instructional design.

## C. Method

### 1. Resources

Three sources of information were used: personal accounts of the individuals who developed lessons and were directly involved in the projects or were in a position to make personal observations; interviews by the editor with

some directors and staff members of various projects; and published documents such as those previously listed.

2. Definitions and criteria for inclusion of cases

Flanagan (1954) developed a technique for arriving at job specifications by documenting and classifying critical incidents. He defined an incident as critical if its purpose was clear and the results were definite enough to "leave little doubt about its effects." This definition has been adapted here for evaluating aspects of CBE projects and has served as a starting point for the inclusion of incidents in this report. Three additional definitions were included to cover other kinds of situations. Thus there were four criteria for inclusion of incidents.

1) A decision or incident was considered critical if the circumstances surrounding it were clear and the results or effects were definite.

2) There were effects or results of situations that could be traced to the fact that a decision was not made. Therefore, for some incidents included here the effects were traced to the failure of a person in a position of responsibility to make a particular decision.

3) There were situations in which a decision had to be made to choose between alternatives. The observed or reported advantages and disadvantages of the alternatives provided valuable information.

4) In some instances, a successful scheme or decision evolved through repeated iterations of situation-decision-effect cycles. Since these situations met the ultimate objective of this report, they were included.

3. Procedures

The initial thrust was an informal "brain storming" session in which the authors reported incidents which came to mind. As each individual recalled events about particular aspects of project development, the memory of others was stimulated and activated. This initial set of events was then organized into what seemed like a reasonable set of topic headings. Subsequently the authors held meetings to add more information and help clarify the definitions and criteria for including incidents in this report. The editor interviewed 12 additional CBE staff members representing 9

different projects, and reviewed more than 20 project papers and reports for appropriate information.

In most projects, several critical incidents resulted, often in various aspects of instruction and management. Since the cases cited below were classified according to topics, rather than projects, it was necessary to repeat the circumstances in some cases in order to make the report more readable.

4. Credibility

It should be noted that the incidents reported below may be somewhat biased. Memory tends to be selective; people tend to remember the dramatic and perhaps fail to recall the ordinary. They may be inclined to recall negative incidents more frequently than positive. In fact, recall may sometimes be somewhat inaccurate. We have tried to minimize this problem by obtaining reports of an incident from more than one source where possible.

The role of an individual within a project also prejudices the incidents he recalls (cf. Flanagan, 1954). In order to keep this bias to a minimum, the people selected to be interviewed were chosen to represent different levels of responsibility and duties. The authors of this report also represent many projects and roles within them. It is therefore hoped that this kind of selection bias is at a minimum.

The experiences reported here are not intended to be used as a final authority for judging the adequacy of CBE projects. In some instances the evidence is scanty and inadequate for making generalizations. The intent is to provide tentative and preliminary information that can be useful as a guide for the planning and management of all facets of new projects.

Some of the "lessons learned" will appear to be no more than common sense. But what is obvious in hindsight was not so clear or even visible in foresight. The purpose of reporting failures, in addition to successes, is not to criticize but rather to emphasize the impact of the various factors in establishing and managing a CBE site.

# Chapter 2

# PROJECT ESTABLISHMENT

## A. Introducing CBE

Introducing CBE involved special problems, above and beyond those usually connected with instructional innovation. The new medium, the computer, was still a relatively recent invention. Most people had not worked directly with computers and were not yet comfortable with them. Some felt threatened by them or were afraid of being replaced. Others expected the new medium to be a great cure-all for many of their problems. Another unusual circumstance was that lessons were often used for instruction as soon as they were finished so that instructors were unable to familiarize themselves with the lesson content and format before their students began to use them (unless the instructors were themselves the authors of the lessons).

The way in which the CBE system was introduced at an institution affected staff as well as students. The extent and the nature of public relations and orientation had a decided effect on the acceptance, cooperation, and expectations of those associated with the project. The incidents cited below show three factors that engendered good will toward CBE and instructor acceptance and cooperation. Broadly categorized, they are: (1) involvement (2) familiarity with CBE and/or the CBE lessons and (3) volunteers as instructors. Desirable attitudes resulted when a deliberate effort was made to provide enough time for the instructor to work on the CBE system or to take some meaningful part in the project, like critiquing lessons or assuming part of the computer's responsibility for instructional management. Conversely, other cases indicate that when teachers were not adequately familiar with the CBE system or were insufficiently involved, they resisted using the CBE lessons and did not make an effort to integrate them into their regular classroom instruction.

Expectations could not always be met as anticipated. In one such instance the project director planned some alternatives in project procedures which enabled the project to progress even though fewer terminals were available than had been anticipated. In other instances, failure of the director to make contingency plans or to furnish explanations for unfulfilled promises led to misunderstandings and bad feelings.

1. Instructor acceptance and cooperation

Case 2A1.1 - Volunteers as cooperative instructors

CBE terminals were to be placed in a prespecified number of classes within a large institution. The project director had to decide on a plan for selecting the limited number of instructors who would have terminals in their classrooms. He decided to ask for volunteers. The instructors proved to be cooperative throughout the project in spite of errors in lessons or other problems that arose. Cooperation was good even among those teachers who knew that terminals would not be available to them the following year.

Case 2A1.2 - Developing good will among instructors

At one site, as an experiment, an entire course was being rewritten to become self-paced. (Parallel CBE and non-CBE portions of the course were to be developed simultaneously.) It was an intricate patchwork of materials from many media. The CBE project director had taught this course and presumbably knew the course instructors. Early in the project, he decided that he and his staff should work very hard to establish good relationships with the instructors and developers of non-CBE materials in order to keep a natural animosity from developing. He lent the other group staff, gave them all signons, taught them to play CBE games, reviewed lessons between project and traditional staff, and paid what any unknowing outsider would deem "unnecessary" attention to details that reduced jealousy between groups. He even went so far as to halt lesson polishing when CBE lessons reached a level where they were clearly superior to the conventional materials. To have polished them more would not only have needlessly added to development time but also might have fostered feelings of jealousy in the developers of the materials using conventional media. The result was acceptance by the conventional staff, and relatively smooth implementation.

Case 2A1.3 - Giving instructors responsibilities

In one large curriculum project the director decided to put curriculum management under computer control. That is, the computer kept a complete record for each student and on that basis decided which lesson to present next. The instructors were unfamiliar with the lessons and with the hardware. Although they had the option of overriding the computer and setting up their own sequence, they rarely exercised it. They viewed the CBE materials as a separate entity and not an integral part of the regular curriculum.

Epilog. In subsequent years, the decision was made to abandon computer management and to give that responsibility to the instructors. By that time they were more familiar with both the lessons and the system. They had to do much more work, diagnosing and prescribing lessons for each student. However, it gave them a sense of power and control over the machine, and they had more students do more lessons than in previous years. The students, in turn, were more interested because the lessons were more appropriate and the teacher showed a vital interest and participated actively.

Case 2A1.4 - Asking instructors to critique lessons

One group of authors wanted to evaluate their materials with students from the target population. They decided that the instructors would be more inclined to cooperate if they were involved in a meaningful way, so they asked the instructors to review and critique the lessons. At that time the lessons were still in a primitive state and had not been carefully pretested. Nevertheless, three of the instructors were positive in their reviews and used CBE lessons with one or more of their classes. One instructor wrote a negative critique and decided not to use CBE at all.

2. Instructor resistance

Case 2A2.1 - Insufficient "hands on" experience

In the first phase of the development of a large curriculum project, lessons were developed by the CBE staff who were not part of the institution that would use them. The decision about the educational level at which to write was made exclusively by the CBE staff. They also decided on lesson content. Instructors who would use these materials were solicited for some advice about lesson content and general demonstrations were given, but no provision was made for "hands on" experience with the materials. This was partly due to the fact there was neither lead time nor a backlog of lessons; lessons were written and used immediately. Also systems limitations made it difficult to obtain time for instructors to try out the lessons. One further obstacle was that teachers had to go to a special room to use the terminals. As a result, most of the instructors treated the CBE experience as a supplementary activity and not as an integrated or important part of the curriculum. They wanted to have little to do with it and resisted becoming involved.

Epilog. When a special time was later set aside for them to come to try out the materials, only 1 out of 25 instructors

showed up even though time for perusal was scheduled for their convenience.

Case 2A2.2 - Insufficient familiarity with lessons

Lessons in a given subject were developed and validated with a particular subject population and were shown to be effective. The lessons were then offered to another institution which had a similar student body. The institution did arrange for review time for any interested instructor. The department chairman (who was very positive toward the material) scheduled enough time so that members of every class could complete all appropriate materials. However because instructors and authors of the materials were busy, no formal attempt was made to insure that instructors at the new site were aware of the detailed content of the materials.

Very few of the instructors took the time to examine the materials. Virtually no attempt was made to coordinate class instruction with the materials. Most instructors simply sent their students to the CBE terminals at the appointed time as an independent activity. Students often got instruction via the CBE system for which they had no class preparation, or instruction that duplicated earlier class presentations. Student attitudes were extremely hostile since they saw the PLATO lessons as a waste of their time. Instructor attitudes were only slightly better.

Epilog. Following the above experience, an effort was made to involve instructors in the revision of the original materials. Although only minor revisions were in fact carried out, most of the instructors viewed all materials and participated in making up a written guide for the coordination of the materials with classroom activities. Subsequent student and instructor attitudes toward CBE and the materials were above average for the institution, although still lower than those at the site that first developed the materials.

Case 2A2.3 - Insufficient familiarity with CBE

Lessons were developed at a curriculum center for use at another institution. Since lessons were used by students just as soon as they were completed, instructors did not have a chance to see them first, and were frequently too busy to make time to view them at all. They were uncomfortable with the CBF system and unfamiliar with the lesson content.

Epilog. Before the second year began, the project director made time available for the instructors to have "hands on" experience before classes started. They felt more at ease with the lessons and this attitude was reflected in the students. Instructors also were able to help students who were having difficulties.

Case 2A2.4 - Schism between staffs

At one site the staff felt that the entire curriculum needed to be made more relevant for the students and decided it should be revised. At about the same time funds were made available to get some CBE terminals. Without further consulting the course instructors, the course director initiated a project to develop an entirely new curriculum while simultaneously initiating the first use of CBE at the institution.

He hired 12 staff members to write the new curriculum, 10 of them new people. The plan was to have the "traditional" staff adapt the content of their courses to the needs of the CBE research project. They were expected to isolate all of their lectures that dealt with a specified topic; then the content was to be given to the CBE staff for lesson writing. The traditional instructors were expected to teach the selected topics at a particular time so that while some of the students attended the lectures, others simultaneously learned the same material via CBE. This entailed a considerable amount of work for traditional course instructors and they did not perceive CBE as a benefit either to the course or themselves. Furthermore they saw the CBE project as research that would never be implemented so they could just wait it out. They had no motivation to cooperate and were slow in turning over lesson materials for the CBE authors to use. They did not come to the terminals, either to try the lessons, to observe the students or even just to play on-line games.

A further source of friction was the fact that the traditional staff had received preferential treatment over the other staff at the school. Because the traditional staff members were developing original study programs, they were exempt from some of the duties that instructors in other parts of the school were expected to perform. They were somewhat ego involved and maintained a "hands off" policy toward their lessons. They were hardworking, but often considered arrogant by other instructors. As a result, they were disinterested and professionally condescending. No one served as an interface between the two staffs. To further complicate the matter, channels of communication were inadequate between the leaders of the two groups and between leaders and their staffs.

Epilog. At about the time this project was ending, the CBE administrator approached staff in other courses and offered them use of the CBE facilities. In this instance, in contrast to the earlier one, CBE was offered as a means of meeting the instructors' perceived needs. They were motivated to use the CBE system to solve their training problems.

3. Expectations and consequent misunderstandings

Case 2A3.1 - Who can use terminals

Staff members of one organization were notified that they were to receive a classroom of terminals. They were not sure that they could fully utilize the CBE terminals. Rather than waiting until the uncertainty was resolved, they spread the word that the terminals would be coming and invited suggestions about their use in other departments. Later they found that there was no excess of terminal availability, so they reneged and restricted usage. The result was antagonism throughout the organization, and members of other departments were reluctant to act as lesson reviewers or to provide students for lesson trials.

Case 2A3.2 - Fewer terminals than promised

At one site, a given number of terminals were promised. Due to a manufacturer's delay, fewer were delivered initially than anticipated. Conseqently the ratio of authors to terminals was about 3 to 1. Since the PLATO terminals were available 22 hours a day, the staff decided to resolve the problem by working in three split shifts. Higher pay was provided as an incentive for night work. The authors claimed that this system reduced tensions. But the administrators said that extra effort was needed to coordinate staff. They reported some problems since the staff members were not always under supervision, and production standards were not well defined. Moreover, the split shifts apparently fostered cliquishness and division among the authors.

Case 2A3.3 - Not as reliable as anticipated

One institution decided to get terminals because validated curriculum material was already available in an area they really needed. Instructors were disappointed, however, because the system was not as reliable as had been anticipated. Administrators decided they had been "used" by the developers for testing hardware. The developers sent personnel to help solve problems, and in-service author

training for instructors was promised. This, coupled with the fact that extra funding would be available if the CBE system was used, led to an improved attitude on the part of the administrators as well as the teaching staff.

Case 2A3.4 - For whom CBE is useful

The president of one institution saw use of the CBE system as a chance to get outside funding and to reduce dependency on tenured teachers, many of whom belonged to unions. Therefore, he decided to assign non-tenured teachers the task of becoming CBE authors. It was also the case that these individuals were in charge of remediation for open-admissions students. As a result, instruction via CBE was perceived by tenured staff as a cheap treatment for the poorer students and as a means of reducing the power of the union by cutting back on the need for tenured teachers. They also suspected that the CBE system was used only for minorities and not at prestigious universities. Persons assigned to aid in establishing the site were unfamiliar with CBE and missed the opportunity to correct these impressions. (CBE was, in fact, used by prestigious universities, and this particular implementation was an attempt to bring advanced technology to schools with fewer resources.) But because of this false impression and the policy of using CBE solely for remediation, senior staff and members of prestige departments avoided using CBE. Students assigned to use CBE became identified as "slow" or "dumb".

B. Choice of Project Director

PLATO projects varied widely in goals, scope, and rate of development. Consequently directors were chosen under different circumstances. Some were individual professors who initiated and developed the project on their own initiative. They learned the TUTOR programming language, authored lessons and generally explored the potential of the PLATO system. After they gained experience in many facets of lesson development, they expanded their staff but continued to be actively involved. Other projects were intended to be demonstrations of use of the PLATO system. In some instances the director was chosen from among the instructor-authors who would use the materials; in other instances an overall project director was appointed to manage diverse projects within a given institution. Such a director was not always available at the time a PLATO project was established. As might be expected, overall lesson production was impeded and slowed in projects which were initiated without a leader or with a temporary one.

Even when such a director was available, he sometimes lacked the essential expertise. CBE was so new that there was no pool of available leadership in the field per se. Consequently the new directors were experts in perhaps one relevant field such as subject content, curriculum development, computer programing, or administration. As it turned out, the most successful leaders were those who were content experts or curriculum developers and who took the time to learn about instructional design and all about PLATO.

In some instances the director expected, or was expected to carry on some other responsibilites in addition to managing the project. Such individuals did not have time to become adequately knowledgeable about the workings of the PLATO system. Not only did they not have first-hand PLATO experience themselves, they did not spend enough time observing the production process. Therefore, when management and policy decisions had to be made, they were necessarily based on second-hand, or sometimes conflicting reports. Many of these decisions were ill-advised and resulted in staff dissension and fragmentation. One director appointed a coordinator to alleviate the problem. It was not successful because the coordinator was not given the authority he needed to carry out his responsibilities.

1. Availability

Case 2B1.1 - Leaderless project

A new CBE project was established but a director could not be found. The individual who was responsible for funding, but not for project outcomes, decided that it would be better to get something going rather than wait for a qualified leader. Consequently he hired staff members, some of them rejects from other projects, and allowed them to work autonomously. Each person developed lessons independently. One member of the group expected to be appointed leader eventually. When a project director finally did arrive, several months later, his efforts to organize and implement a work plan were thwarted by individual members who had vested interests in materials already developed and in directions already taken. Productivity of the group fell and much time was spent in behind-the-scenes struggles for power.

Case 2B1.2 - Temporary administrator

A project was tasked with implementing an experimental curriculum requiring a variety of high-level cognitive and affective skills. The project was expected to last for three years including training of staff, development of CBE

materials and evaluation of their cost and instructional effectiveness. It was difficult to find a suitable individual to oversee the curriculum development since highly technical expertise as well as curriculum development skills were needed. The curriculum developer joined the project six months after its beginning. Meanwhile a temporary leader was in charge. He was faced with two alternatives. Although not qualified, he could make fundamental decisions for the project which would allow it to begin productive work from the beginning. Alternatively, he could postpone these decisions until the arrival of the curriculum developer and allow the project's authors to develop lessons in whatever areas they felt might be useful to the project. He selected the second alternative.

The lessons which were developed in the six month period before the curriculum developer arrived were for the most part unuseable; they simply did not fit into his plan for the project. Ultimately the project failed to meet its intermediate and final production deadlines. The inability to use all of the project's time effectively was probably detrimental to its successful conclusion. Moreover, the early loss of time forced a hasty and slipshod manner of lesson development in attempts to meet the deadlines.

2. Diverse qualifications of directors

Case 2B2.1 - Content expert studied CBE

In at least four projects the director was a content expert who had teaching experience and/or had taken courses in instructional design but had no experience with CBE. Rather than begin staffing and rely on experience with other media for setting project policies and goals, the new director spent one or more years learning the TUTOR language sufficiently well to produce and test several alternative types of instructional approaches that might make full use of the medium.

Therefore before he began full staffing he had a good understanding of the alternatives in project development and was able formulate clear goals. The projects ultimately produced large amounts of good material on a tight schedule. This was so, even though problems sometimes arose in the selection of an experienced programming staff whose views fit in with those of the director.

Case 2B2.2 - Expertise in instructional development

The individual who was chosen to head one project had experience developing instructional materials for the audience and institution which was implementing CBE. The

staff he chose had varied backgrounds. Some were experienced teachers and others were subject matter experts. Only one other person had experience developing instructional materials. The lessons produced under his direction were for the most part effective and useable. The experience of this director in the production of instructional materials seemed to make him aware of the need to make maximum use of all available time. When delivery of terminals for his site was delayed, he used the time to teach the basics of instructional design to his staff and planned for sharing terminals with a nearby site.

Case 2B2.3 - Non-adaptive application of expertise

The project leader was experienced in innovative curriculum development, particularly for special subgroups of students. He decided to transfer the old materials to CBE, using his same lessons and instructional strategies. He did not take into account the differences between CBE and classroom interactions. Many of the lessons were not suitable and students rebelled at doing them. Many lessons had to be scrapped or essentially rewritten. Considerable time was wasted and the project fell behind its goals.

Case 2B2.4 - Superb programmer

An administrator appointed a project head who was experienced in a subject area related to that intended for CBE, but had no teaching experience with the target population nor with the exact subject matter. He was apparently a hotshot in programming. The result was that he directed the efforts of the project to developing an extensive computer-managed instruction capability. Insufficient time was allocated to writing instructional material. There was not enough time to produce as many lessons as were needed, and very little time was allowed for student trials. Many of the lessons that were produced turned out to be unsuitable for the intended students.

Case 2B2.5 - Expertise in administration

In several instances, the project supervisors were administrators who had neither experience teaching the target population nor subject matter expertise. They made the decision to discard certain lessons, based on their reactions that the lessons were too "boring" or "too easy." But the authors felt that the presentation was at an appropriate difficulty level for the students. They convinced the directors to allow the lessons to run and to let the data be used as a basis for decision. Data showed that

students liked the lessons and also had a favorable attitude. The lessons were retained and used.

3. Part-time leaders of large projects

Case 2B3.1 - Too many duties

An individual was hired to be general supervisor of several CBE projects and to be directly in charge of one of them. In addition, he brought with him from his previous position some continuing projects. He decided that he needed time to learn to write lessons to get a better feeling for what was involved. However he could not find time to do so, nor could he even find time to observe students working at the terminals. In many cases he made ill-advised decisions and judgments about what kinds of lessons would be successful. Staff members became increasingly reluctant to ask for his opinion on such things and worked independently. Eventually he had almost no time to devote to the CBE project. The staff splintered into factions and morale was low.

Case 2B3.2 - Coordinator, responsibility without authority

In four different projects, the leader of the curriculum group was also responsible for many other activities and had no time to engage in day-to-day operation of the group. He made policy decisions which were, in most cases, made solely on the basis of reports rather than personal observation of the situation or the materials being developed. He appointed a group coordinator to give day-to-day supervision. The coordinator delegated assignments but was given no authority to make and enforce decisions. The leader gave no general guidelines and left planning to the coordinator. The leader encouraged group members to report problems directly to him rather than work though the coordinator. Decisions resulting from such conferences were often revealed to the group before the coordinator learned of them or had a chance to give counter arguments. The coordinator eventually became little more than an assistant to the project leader. Daily operation of the group became fractionated since the group members would only follow directions of the overall leader who was rarely present or available. A good deal of group effort was spent in "political" infighting. There was no overall structure or framework for lesson development. The totality of lessons was not a coordinated whole, but fragmented pieces.

In some cases the director received conflicting information. Since he did not have time to verify stories, he resolved the conflicts by counting the number of people telling the same story. He then made decisions about

project policies on this basis. Sometimes this resulted in the over-ruling of unpopular suggestions that had been made by an experienced instructional designer who was nominally responsible for day-to-day operation of the group. The group went leaderless, morale fell, and productivity was almost nil.

Epilog. The entire group was reorganized under a new director. Although the new director could only devote a fraction of his time to administering the project, members of the groups had gained enough experience so that they were able to work independently. Even so, deadlines were so near by the time the groups became productive that only minor parts of the original production goals were reached and overall quality of the materials was mediocre at best.

## C. Staff Selection

The effectiveness of each project was sometimes impeded and sometimes enhanced by the way in which staff were selected and trained.

In order to select a project staff, the project leader needed to specify the qualifications he was looking for. Early in the development of PLATO projects it was known that successful lesson authors were experienced in more than one area, such as lesson design, subject matter, and programming. However there were very few people around with all of these qualifications. In addition there were no formal training programs in the early years, so individuals learned on their own or project directors developed their own training in whatever way they could. The first formal author training program underwent several iterations before it was evaluated as successful three years after PLATO IV was implemented (Francis, 1976).

Directors were not always free to choose the entire staff. Sometimes individuals were carried over from a previous project. Sometimes new staff were hired simply because they were available and interested at a propitious time. Some staff were students who wanted to learn how to author PLATO lessons. Others were individuals with expertise in perhaps just one area like programming or teaching or instructional design. Still others were instructors who were released from all or part of their teaching duties in order to develop PLATO lessons. It seems that both teaching (or curriculum design) experience and subject matter expertise were necessary but not sufficient qualifications for good authoring. Instructors who had only lectured and had not interacted with students on an individual basis were not adequately sensitive to the student's needs. They tended to equate teaching with presenting and incorporated very little

interaction in their lessons. Skilled programmers who had no teaching experience produced lessons which were ineffective. Retraining carry-over staff was relatively unsuccessful. A director who decided to retrain underqualified carry-over staff later expressed some misgivings. Such staff required greater than average consulting assistance and many of the lessons they produced were poor or unuseable. In another incident authors who had previous CBE experience were retrained to use the TUTOR language. Many of these authors were unwilling to learn about the new and more sophisticated aspects of PLATO or to apply that knowledge to producing PLATO lessons. Instead they wrote materials patterned after the inefficient lesson formats which they had been required to use previously.

When instructors were given released time to write lessons, they needed at least half-time release to be effective. Persons with very limited amounts of released time spent most of their time in "warm-up" or overhead activities and contributed little to a project. Even half-time release was not always effective. The intent to provide half-time for CBE was honest, but it could not always be honored. Teaching duties differ from CBE responsibilites in the immediacy of the needs, deadlines, and payoffs. When the total work load became excessive, teaching duties such as meeting a class, took precedence over lesson writing. Consequently teaching sometimes took more than the 50% time allotted and CBE lesson writing suffered accordingly. On the other hand, full-time release was not always successful because the instructors became isolated from the other instructors and from the problems of the students.

A decision specific to the military environment was whether or not to employ civilian staff. The decision to choose both military and civilian authors worked out satisfactorily at 3 of the 4 sites observed. At the fourth site, pay differentials for equivalent work caused an exodus of military authors.

1. Qualifications

Case 2C1.1 - High turn-over subject matter experts

The director at one site was not free to choose his own personnel to author CBE lessons. Most of his staff were subject matter experts (SME)on one-year assignments to a training organization. The SMEs were trained in TUTOR, and programmers were hired to help them develop lessons. The programmers were effective in helping them, but the ratio of 1 programmer to 4 authors was inadequate to meet the authors' needs. The lessons produced were essentially like

textbooks. One frame after another was an extensive display of text. Very little interaction was incorporated in the lessons.

Case 2C1.2 - Teaching experience

In another project personnel had already developed useful lessons. A new director arrived with some of his former staff members. They had teaching, but not CBE, experience. They tried to make CBE fit old molds, refusing to learn from experience of existing staff. This resulted in bad relationships between the old and new staffs and ultimately in inefficient program implementation.

Case 2C1.3 - University students enrolled in CBE course

Students enrolled in a university course for the specific purpose of learning how to write lessons on the PLATO system. Since the professor's department had no funds for developing PLATO lessons, he decided to have the students write lessons that could be used for a beginning course in his subject.

The result was an exceedingly diverse set of lessons of varied quality, depending on the abilities and motivations of the student author. Some lessons contained gross errors in content. Staff members were able to get lessons revised for content accuracy, but it was often difficult if not impossible to get the student author to make other kinds of revisions, such as spelling, or more reasonable answer-judging. The first time the lessons were used for a regular class, the CBE students indicated that they enjoyed using the PLATO system. However, they did not do as well as the as the non-CBE students on exams. The instructor ascribed this performance difference in part to lesson inadequacies and errors.

Epilog. The instructor subsequently decided to revise the lessons himself, at a considerable investment of time. Classes that used the revised versions then performed as well as non-CBE students.

Case 2C1.4 - University students, extracurricular activity

Department funds were not available for developing CBE lessons. The decision was made to have student programmers write lessons. The students seemed to learn the material they programmed themselves, but the lessons could not be used to teach other students. An instructor finally ended up revising some of the more promising lessons and supplementing them with lessons written on his own time.

2. Special considerations in military environments

Case 2C2.1 - Both military and civilian authors, unsuccessful

At a military base, the administrators were uncertain whether civil service staff or military staff would make better authors. They decided to make a small research study of the issue and to select half the staff for the project from each and to study the differences later. The civilians had comparatively precise job descriptions and a higher pay scale than their military colleagues. When the system was "down", traditional course authors complained to the director that the CBE authors were just "sitting around." So the director imposed demeaning clerical and janitorial work on the CBE staff group during down time. The civilians were able to point to their job descriptions and thus escape--doubling the "nasty" work for the military personnel. This, combined with their lower pay, created a substantial morale problem for the military authors. Many left or tried to leave before the project's end--thereby causing substantial problems and delays while new staff were identified and trained.

Case 2C2.2 - Both military and civilian authors, successful

At two other military sites, civil service and military personnel worked together without major problems. There were apparently small differences in pay and virtually no differences in duties or responsibilities.

Case 2C2.3 - All military authors, personnel changes

One military project was acquainted with the situation described in Case 2C2.1. So they decided to have an all military staff. Most of the selected staff were officers, and thus they did not encounter the problem of demeaning janitorial duties being foisted on them, as at the other site. Obviously no military-vs.-civilian problems arose. However, this project had to deal with the severe problems which any group which includes military personnel must be prepared to accept. That is, promotions and reassignment of personnel forced reorganizations of the CBE project, with the attendant loss of efficiency.

Case 2C2.4 - All military authors, problems due to rank

At a military site, the external supportive institution encouranged the director to include instructional designers and evaluators as part of the lesson development group.

Consequently, an experienced lesson designer was assigned to assist the CBE authors. He held a lower military rank than the authors. Even though he was very competent, and the authors would have written better lessons if they had followed his advice, they largely ignored him because of his lower rank. A different instance of the effect of military rank is given in Case 3A3.1 below.

3. Carry-over staff from antecedent projects

Case 2C3.1 - Retraining existing staff to be authors

One project was set up during a period of tight organizational funding and a shortage of local manpower. There were no funds to hire new staff and the existing pool of unassigned personnel from which to staff the project did not contain qualified individuals. The project director was advised he had two choices: employ the under-qualified staff and use them as best he could, or employ no one for those positions for the term of the project. That is, the positions could not be held open so that better qualified staff might later be added.

The director decided tht slow producers would be preferable to understaffing the project and hence filled all his positions.

The shortcomings of the staff forced the director to revise his management of the project. He devised a team-oriented approach so that the weaker authors could serve mainly as subject matter experts. One person was removed entirely from programming/subject-matter duties and given clerical/editorial responsibilities until his position could be terminated.

Epilog. At a later time, the director and his assistant expressed some misgivings about the decision. The under-qualified staff consumed an excessive amount of the time of on-site and off-site consultants. Their work was sometimes unacceptable and required complete reworking by more-qualified staff. But the fact that some of the staff were well-known in the institution probably enhanced the acceptance of the materials.

Case 2C3.2 - Failure to adapt to new features

Some members of the staff at one site had used another CBE system. They often tried to force their PLATO lessons into old molds and were reluctant to use more sophisticated and powerful techniques on a new system. For example, they did not use the data-keeping features of the PLATO system but rather devised cumbersome, less informative, but

familiar routines similar to those which had been used on their previous system. Some staff had been editors of programmed text. Initially they attempted to use CBE as a programmed text ignoring the possibility of using feedback. The lessons were boring and ineffective.

4. Staff from within, released full-time

Case 2C4.1 - Isolation from other instructors

Instructors at a college were given full-time for production of materials and complete freedom in setting objectives although they had no prior experience in either instructional design or CBE. Although they became proficient with the CBE language, their total lesson productivity was not impressive. Moreover, they were perceived by other members of their departments as "outsiders" and had difficulty in scheduling trial use of their materials by students. In one instance, a person produced no material at all during a year of released time and left the school for another position near the end of the period.

Case 2C4.2 - Isolation from students

Regular instructors were released to be CBE authors but they had almost no experience in any aspect of CBE. They tended to produce material without attempting to test it with students or relate it to student needs. The rate of production was also rather low because deadlines were in the distant future.

Case 2C4.3 - Military setting, isolation

A number of instructors at a site were chosen to become CBE authors. They tended to be the younger and better educated of the group. Those who were not picked thought that the CBE people were somewhat of an "elite" group and had the easier and more interesting job. The CBE staff no longer did any teaching and their lesson writing became isolated from the course. The lessons they produced were of variable quality. This situation, coupled with administrative problems, the small flow of students, and the fact that there were no real problems teaching the course in the traditional way, resulted in little use of the lessons.

At another site with a nearly identical situation, one of the authors, making an exit interview, stated he felt that one author working full-time would produce less than two authors working half-time, and that the latter would better be able to relate the lessons to the student audience and to smoothly implement the lessons.

5. Staff from within, released part-time

Case 2C5.1 - No CBE experience

In 2 college level courses, instructors with no prior instructional design or CBE experience produced little material during an initial year of 50%-released time. But they were able to test those materials within their own courses and develop effective instructional approaches which led to production of substantial amounts of material in later years.

Case 2C5.2 - CBE experience

In three college level courses, instructors who had spent two or more years developing CBE materials on their own time were given half-time release to consolidate and supplement materials already produced. Productivity was quite high in two cases and in all cases the released time resulted in substantial additions to the amount of material available to the departments involved.

Case 2C5.3 - Less than half-time release

Regular instructors were released 1/4 time to develop instructional materials for CBE. That was not enough time for them to write lessons. The best they could do was review lessons that others had written and sometimes they could do little of that. Almost nothing useful was accomplished.

In one instance a person with 1/6 released time reported that he felt that he had made no contribution at all to the project. This view was shared by other members of the project who felt that the efforts in attempting to train him had wasted limited resources. Attempts to avoid this problem resulted in a range of released-times tried by a number of projects.

## D. Planning the Project

In order to schedule CBE lesson production, project directors needed information on which to base plans. The only data that were initially available were based on a special group of highly-experienced workers. Their data were cited in response to questions from directors of new projects, but the fact that the data were for experienced workers was often not communicated effectively. Even after more complete data became available, figures of 30 hours of production time for one hour of student contact time (valid for one set of very proficient authors) were cited rather

than figures of several hundred hours per contact hour (valid for new authors during their first year). Consequently, planning for production, when done at all, was often predicated on production rates that were impossible and unrealistic for the untrained workers available to new projects.

Some directors made overambitious plans, which led to failure to meet deadlines. In cases where no contingencies had been planned and deadlines could not be met, the decisions of project directors varied from just doing the best they could under the circumstances to giving up lesson writing entirely and writing routers for managing lessons which had been written by others.

Administrative organizations of the projects also varied considerably. Some projects, particularly in the military, brought together a number of individuals to produce a fixed number of lessons in a given length of time. Directors tended to underestimate the time that would be needed and some also failed to arrange for contingencies in case they would be unable to meet their goals. The successful projects were the ones which were planned so that lessons could be effectively used even if goals were not completely met.

Some projects evolved gradually, with a single individual first gaining experience writing individual lessons, and later on assembling more staff members and creating a curriculum. Many of these were highly successful projects.

Another administrative question that had to be addressed by a CBE project director was how much planning to do ahead, and how much to leave open and subject to the discretion of the author. This was particularly relevant for projects that used the PLATO system, where it was a simple matter to "compose" and/or revise lessons at the terminal. The system does not constrain the lesson developer to make long range commitments to a fixed plan which will be difficult to change at a later time. Early projects varied from detailed planning to some general planning with just a few details prespecified, to almost complete improvisation. The two extremes were apparently the least productive in the long run.

The selection of appropriate media was an important consideration in project development. CBE is not always the most suitable medium for all instruction. When project directors used PLATO instruction exclusively without considering the appropriateness of such use, the CBE lessons were frequently ineffective, boring, and not cost effective.

1. Production goals

Case 2D1.1 - Working from the end of course to beginning

At one military site, plans were drawn up even before training was begun in the programming language. Since a standard course of instruction was already in use, the task of the project was to develop parallel CBE instruction. The decision was made to write the last lesson of the course first and then continue to write in the reverse order in which the lessons would be used. Several advantages resulted. The student did not have to wait for a lesson until the whole course was ready. He simply worked in the standard mode until he reached the point where the CBE lessons were ready, and then continued with them until the end. There were other advantages to this plan. The first CBE lesson the student encounters sets his attitude toward the medium. Since the author's first lessons are apt to be his worst, it is best if if they are not the first CBE lessons the student encounters. In the plan under discussion, the student did not encounter the author's first lessons until the end, by which time he was hopefully tolerant of its shortcomings and more adapted to the medium. Finally, evaluation was possible even though not all of the lessons originally planned were completed.

Case 2D1.2 - Fixed number of hours, no contingencies

Some projects were given some latitude in setting their own goals. Thus, they were free to set goals in terms of topics to be covered or in terms of student contact hours they would provide.

In two instances, inexperienced project directors set goals far beyond the resources of their groups and failed to make any attempt to provide alternative goals should the planned ones prove impossible. Despite continued slippage of deadlines, the planned goals were maintained until final deadlines were so close that it was obvious to all that there was a real chance for total failure of the projects. As a last-minute alternative, all attempts at lesson production were abandoned and lessons written by other groups were adopted (despite the fact that many of these materials had been regarded with contempt a few months earlier). Ultimately, the adopted materials were arranged in well-documented packages that were accessed by specially designed routers. While the final "product" was a reasonable outcome of the project, it would probably have been of far higher quality had the original goal been altered much earlier.

Case 2D1.3 - Inappropriate basis for production schedule

The decision was made to develop lessons which would supply a specified number of student contact hours. Plans were erroneously based on planning guidelines which applied to experienced rather than the inexperienced authors employed on this project. As a result, the director grossly underestimated production time requirements. He further failed to provide alternative plans should the original goals prove impossible for any reason. When it became obvious that the original goals were unattainable, they were substantially scaled down (and contingency plans were made for future problems). This alteration of plans under pressure of potential failure (rather than as part of a planned sequence of alternative goals) was demoralizing to all participants of the project and tended to lead project directors to engage in "cover-up" and blame-shifting tactics rather than in activities directed toward improving instructional quality.

Case 2D1.4 - A complete set of lessons

Plans for one project entailed a new curriculum to be developed on a new medium, CBE. All the lessons in the course had to be completed in order to judge its effectiveness. This virtually eliminated the possibility of a "partial" success since unless all the lessons were completed there could be no project evaluation. When it became apparent that all of the lessons would not be completed by the deadline, the entire project was scrapped, officially for other reasons. However, the impending failure to complete the lessons was a major contributing factor.

Case 2D1.5 - Incorporate lessons as they become available

In at least three projects, the production goals were specified in terms of lessons covering particular subject matter topics. At first the project director was the only author. As soon as lessons were "finished" they were incorporated into courses in appropriate places. Eventually, the director added some staff members. Although completion deadlines were not strictly pre-specified, production progressed well. This was possible because the directors themselves were competent, highly motivated authors who stayed in constant contact with their staff. They set realistic goals but in an informal, flexible setting.

2. Prespecification of all routing

Case 2D2.1 - Isolation of instructor from CBE

Curriculum materials were written at a development center for implementation elsewhere. The project director had the alternatives of making the program completely self-contained or requiring instructor intervention. He chose the former. He therefore decided that the entire curriculum had to be mapped out before any student trials were attempted. This included writing every objective and routing contingency. Since the full weight of instruction fell on the CBE materials, a great deal of time had to be spent by the staff in altering and maintaining the elaborate routing and branching structures. They did not have time to revise the lessons themselves or to add new ones where necessary. Since the lessons had minimal pretesting with students, they often needed a good deal of revision if they were to be effective. The instructors felt that since the router was doing all the work, they did not need to get involved. When problems arose they did not try to find solutions themselves, but rather called on the CBE staff. Furthermore, they felt frustrated because the lessons were not meeting the needs of the students, and there was nothing they could do about it.

Epilog. The router was scrapped and a new one was written. This one made it the teacher's duty to select lessons for the students. The task for the teacher was made as simple as possible. Although this made some extra work for the teachers, they became increasingly involved in CBE as a regular part of instruction. Also, as they became more familiar with the terminals and felt more at ease with them, they began to try to solve some of the problems themselves. The instructors' calls for help from the CBE staff decreased noticeably, and it became possible for the CBE staff to concentrate more on improving the instructional quality of the materials.

3. Failure to define goals

Case 2D3.1 - No clear goals

At one site, authority for decisions on project goals was divided between two groups. It took four months to get approval of an initial set of plans. During that time the student population changed. Moreover, the plans turned out to be impractical due to lack of experience with CBE at the time they were written. New plans had to be formulated. A major obstacle to approval was a conflict in the goals of

the two groups. One was interested in seeing CBE deliver instruction; the other was research oriented. The project thus went along without clear objectives. Lack of decisiveness resulted in frequent changes of plans. For all practical purposes, every time a plan was changed, the progress in the previous period was cancelled. The net effect was very limited progress for the project.

4. Media selection

Case 2D4.1 - Failure to be selective

At several sites the project directors assumed that since CBE was to be used, it had to be done to the exclusion of other media or had to be incorporated somehow whether feasible or not. At one site, the most effective medium for a task was videotape, so the project director decided to use PLATO by having it control the videotape. In another instance, an author suggested that a particular lesson be presented as a handout, but the project director decreed all lessons must be in CBE. The result was a lesson that was boring and costly.

# Chapter 3

# PROJECT DEVELOPMENT

## A. Director's Role

As PLATO projects evolved, some continued under the leadership of the initiator. Others underwent one or more changes of directors. In many larger projects, the organization necessitated several levels of authority and in those cases administrative structure varied. For example, within a single institution, CBE lessons were being written in several subject areas. Each group had its own project leader and all such projects were under the supervision of a higher level administrator. In some cases the top level director was also the director of one of the sub-projects; in others he was essentially a coordinator and administrator in management rather than in curriculum development.

Unfortunately, roles and domains of authority were not always prespecified in these multi-level authority groups. Leaders at the same or parallel levels of authority could and sometimes did intrude on the projects of others, giving conflicting directives. When this happened, staff were confused and progress was hampered.

As noted above, leaders who chose to be in constant contact with projects were a positive force in successful development and could often prevent problems from developing.

Project progress was sometimes slowed due to a change of directors. In at least two cases, this happened because the new director ignored the accumulated knowledge of his predecessor and started from scratch.

A special problem in the military situation arose when promotions raised a staff member to a rank above that of the project director. The new senior officer assumed responsibility according to military code, and the structure, roles, and responsibilities previously set up were left in disarray.

### 1. Keeping in touch

Case 3A1.1 - Positive result of support

At one large institution, CBE lessons were being developed in several departments. The top administrator, who had overall responsibility for the individual projects, chose staff for each project and kept in personal contact with the staff and projects. This was a major factor in helping him develop a viable CBE group in at least one department.

Case 3A1.2 - Intrusion

A number of projects were headquartered at a curriculum development center. Authors worked in proximity to those from other groups as well as their own. A high-ranking member of the center staff took a well-intentioned interest in projects for which he had no responsibility and made suggestions which were interpreted as orders and which sometimes conflicted with those of the real leader. The result was confusion on the part of project members, divisive power struggles in which staff members pitted the word of one leader against that of the other, and lower productivity.

2. Effect of changing directors

Case 3A2.1 - Reinventing the wheel

In two cases, after the project had been under way for a year or more, the director left and a new one was appointed. When the new director arrived, he began the project anew, as if nothing had been done previously. He was not interested in learning from or building on previous experience. Often these new directors brought in their own staff at better pay than the former staff even though the new staff was inexperienced in the skills needed for CBE design and required training by the old staff. Morale and productivity of the old staff fell, many mistakes were repeated, and time was wasted.

3. Military role conflict

Case 3A3.1 - Military role conflict

The director of a CBE project at a military site was chosen for his background and experience in administration. He was hired early in the project before other staff were present. He designed a structure, established roles, and began the project. Several months later, one of the staff members, an author, was promoted (on the basis of previous service) to a higher rank than that of the project director. As the ranking officer, military code held him responsible for the operation. Role distinctions became confused as the lines of authority were rearranged. Personality differences between the two leaders added to the stress. The original leader was greatly liked and respected by the staff while the new, ranking leader was disliked. The continuing presence of the former director on the project also added to the confusion of some staff members.

Case 3A3.2 - Non-supportive aid

One consultant who was a good programmer and who had done most of his consulting with persons interested in computers rather than instructional design was highly critical of anyone who did not readily grasp the CBE language. One trainee who ultimately turned out to be a very effective instructional designer was ready to quit after being told that he would "never be a good author" by this consultant. A more supportive consultant who was more oriented toward instructional design was able to salvage the situation at the last minute.

## B. Staff Considerations

The software staff for PLATO IV declined to make available a printed manual about the TUTOR language. Such a document had been prepared for PLATO III. However, since the system was continually evolving and changing, the manual soon became incomplete and parts of it became obsolete. A hard copy manual for PLATO IV would have had the same shortcomings. It was precisely these two factors, the evolutionary nature of the programming language and the lack of a printed manual, that made learning TUTOR particularly problematical for new authors. Consequently a strong supportive environment was important and contributed heavily to the progress of successful authors. Many of the best authors were trained in an apprenticeship-type relationship with experienced authors. Other projects found that author productivity was improved when the services of an on-site consultant were available. In several incidents, where would-be authors made slow or little progress, part of the difficulty could be traced to the lack of psychological support. They were expected to learn authoring by themselves without the regular guidance or consulting services of an experienced individual.

Some projects were organized to include lesson designer-programmer teams. When the programmers were students, hired on an hourly basis, personnel turnover was high and progress was impeded. A more successful arrangement resulted when the programmer was treated like a professional: held a regular appointment, (preferably at least 2/3 time) and regarded the work as a job with top priority over other activities. One other factor that fostered smooth relationships was the decision that the lesson designer think the lesson through carefully and perhaps design a few displays before turning it over to the programmer. This system minimized the number of revisions that were needed later. The programmer no longer felt that all of his previous work was wasted because total rewrites were rarely necessary.

1. The need for a supportive environment

Case 3B1.1 - Apprenticeship relationship

In two subject areas, project directors initially developed their own CBE lessons. After these lessons were in use by students, the directors hired additional personnel to write lessons. They did not provide a formal training course. Instead, the new authors reviewed many of the existing lessons to get some concept of the scope of the lessons and the capability of the CBE system. Then they learned the TUTOR language on their own. When they began writing their lessons, they worked in an apprenticeship relationship with the director and other experienced authors. The new staff member could rely on his mentor as someone who really understood the complexities of CBE authoring and who was supportive of his/her trial-and-error efforts as well as initial successes and failures. This kind of relationship was a positive factor for the author's morale and productivity.

Case 3B1.2 - Senior programmer as part-time consultant

In several groups a senior programmer was available for quick personal consulting for staff who were learning TUTOR. This enabled them to make reasonable progress while learning. It also prevented needless frustration. In addition, the experienced person could guide the new author by indicating which parts of the language to learn immediately and which to leave for a future time.

Case 3B1.3 - Different roles of consultants

One project manager decided that his group needed the services of an on-site programming consultant, so he hired one. The authors were glad to have this help and lesson development progressed well. However, the manager expected the consultant to also serve as a monitor to improve lesson quality . The manager was disappointed that the consultant did not assume this additional responsibility.

At another time, a member of the CERL staff provided part-time consulting services. He worked at a personal, rather than at a group level. This was necessary because the frequent change in leadership meant that the only long-term (months) relationships that could be formed were with the authors. Eventually the consultant's opinions and advice were used as the basis for the struggles for leadership. When a final management structure was established, the consultant was expelled because of the perception that his role and influence were disruptive.

Case 3B1.4 - No programmer consultant

A site director obtained four PLATO terminals because he wanted to provide access for both staff members and students. He verbally encouraged use of the medium, but decided to save money by not hiring anybody with the specific responsibility of providing programming service and assistance in learning about the system. The result was a very limited development of expertise at the site. 1) The staff who were using the PLATO system had little free time and felt no responsibility or inclination to program for others. 2) The undergraduate programmers had little feel for teaching, little time available for hire, and high turnover. As a consequence, at least one mini-course slated for implementation on the PLATO system was put on other media because no dependable, rapid programming aid was available. The CBE center was used rather casually for learning how to use another language and for recreation. It was used for actual CBE training by those few instructors who had written lessons or who knew how to access materials written by others.

Case 3B1.5 - Insufficient references and no training program

Shortly after the implementation of the PLATO IV system, several educational institutions sent full-time instructors to CERL to learn the TUTOR language and to write lessons. No formal training program was available, nor was any printed material available for reference. At that time there was also a shortage of terminals, so that trainees could not always get one when they needed it. They had to share facilities with experienced authors who often gave them personal help but also sometimes left the trainees with the feeling that they were intruding. Because the staff at CERL did not yet understand the need to provide training and consulting support for outsiders who were novices, they largely ignored this group of would-be authors. The person who was assigned to give this support had other full-time duties and could not devote the time needed to teach them. Some documentation of the language was available on line, but it was intended to be used as a reference for experienced authors. It did not fulfill the needs of these beginning authors. They felt growing frustration at seeing things that they wanted to program but were unable to. The result was that at the end of the year little useable material had been produced and these individuals were dismayed at how long it took to prepare lessons.

2. Lesson designer, programmer relationship

Case 3B2.1 - Inadequate pre-planning by designer

The leaders of one project were experienced in CBE lesson design, subject matter, and teaching the target population. When they decided to use the team approach to lesson development and hire programmers, they made inquiries about potential problems in this arrangement. One of the most commonly cited was the fact that some lesson designers assigned a task to a programmer without "enough" careful consideration. After the programmer had invested a considerable amount of time preparing the lesson, the designer would frequently decide that wasn't what he wanted after all, and would scrap the lesson for another plan. This was bad for morale; programmers felt their time had been wasted. This director therefore made it a policy to try not to assign a lesson for programming until it was carefully thought out. Sometimes the lesson designer did a few displays first to see what it would look like or to demonstrate what he wanted. The result was that lessons were seldom discarded and the programers did not feel they were wasting time. On the rare occasions when the lesson was not successful during student trials, and had to be revised considerably, the programmers understood and morale did not deteriorate.

Case 3B2.2 - Professional part-time programmers

One group hired student programmers on an hourly basis. They found that this was not satisfactory because there was a high turnover in personnel. This meant considerable time had to be spent orienting new people to the particular plans and conventions of their project. Moreover, students who worked less than half time sometimes found they did not have enough time to fulfill all of the commitments they had made. Studies and other activities took priority over their programming job. The decision was made to hire "professional" programmers: that is, people who considered this work as a job, and who could devote at least half time to it, but preferably 2/3 time. They stayed with the project longer and were more productive.

3. Difficulty adapting to CBE

Case 3B3.1 - CBE different from classroom

New authors who had considerable classroom experience found it difficult to adjust to CBE. They tried to model their CBE lessons on instruction presented in the classroom.

They failed to take into account the differences between these two modes.

In the classroom these instructors used the discovery approach to learning, guiding the students by asking pertinent questions. Although some of the students could not answer the questions themselves, the brighter students did. Thus the teacher did not have to provide the answers because classroom interaction enabled the slower students to learn from faster ones. In the CBE lessons, however, all of the interaction was between student and lesson. Therefore, more lesson guidance was necessary in using the CBE system than in the classroom. Considerable time was wasted writing unsuccessful lessons which provided inadequate guidance and feedback for the students. When the authors observed student trials, they found the students openly rebellious. The authors decided to revise the lessons. They provided more explicit instructions and adapted the difficulty level to the needs of the students.

4. Arrival of staff

Case 3B4.1 - Staggered arrival

In preparing for a large project-oriented development site, the majority of the authoring staff were given training at CERL and then sent on to a given site to write lessons. Six months later, a second group of staff (who had been selected earlier, but were not then available) arrived at this site. The author training for the new authors was slightly re-oriented to adjust for what were perceived by the trainers to be weaknesses in the backgrounds of the first group of authors. In particular, instructional design training was emphasized. When the second group returned to the project site, they considered themselves missionaries to those who were already established. Conversely, the old-timers had already formed ideas about how to do things and considered the second group novices whose opinions should be taken lightly. Furthermore, decisions made in the first part of the project were not not always explained to the second group. Friction resulted and the second group failed to become assimilated into the first.

5. Job security

Case 3B5.1 - Low morale

In at least three cases, the staff knew that the project was scheduled to run out of funds. The directors gave no indication of whether further funds might be forthcoming or whether other projects might employ them when the current

project ended. Since the staff did not know whether their jobs would still be available, they lost motivation and wasted a considerable amount of time. Often, project reports and other deadlines could be achieved only if the entire staff worked up to the last day of the project. In some cases, when faced with the prospect of impending failure, many staff members obtained other positions well before the end of the project and left early. As a result, projects were completed well beyond deadlines, or in a slip-shod fashion.

### C. Models of Organization

Mahler and his colleagues (1976) reported that each of the 16 projects they interviewed had a unique organization. Generally, these authors found four broad categories for classification. These were: independent developer, a colleagueship, a lesson designer with programming assistants, and some combination of these. Many of the groups modified or changed their organization in response to experience and to the shifting needs of the project. No one plan was good for every group. Each had advantages and disadvantages.

Early in the development of the PLATO system, authors were mostly professors who learned TUTOR. Some of them became proficient programmers and produced lessons readily. When they hired new staff members the new staff, too, became independent authors. All liked this system because it enabled them to experiment with a wide variety of teaching techniques and ways of using TUTOR. It did not force them into a predetermined lesson structure, but enabled them to observe results and to take newly-gained information into account for succeeding lessons. Other professors found that they were unable to produce lessons as rapidly as they would have liked--for example, because of difficulties in programming efficiently--and hence hired staff whom they could direct to do those things they themselves would do if time and efficiency were not important.

Following the export of the PLATO IV system from the university environment, "instant" versions of the first approach were tried with varying success. For example, several staff were hired and set to work using the independent approach described above. Without the experience built up from several years of exploratory use of CBE, these efforts were not overly successful in creating entire curricula. The authors' independence and lack of experience resulted in wide variations in lesson styles and quality.

The shift to a team approach met the needs of some projects but it was abandoned or modified by others. Its success depended on the qualifications of the staff and

the goals of the projects. In three different projects, when programmers were hired to code for lesson designers, they became overly creative. They embellished and implemented the lesson in a way that was neither specified nor intended by the designer.

In cases where the programmers were part-time graduate students, scheduling problems resulted in inefficient production rates. Some directors decided to return to individual authoring and to depend on consultants to help them with particular problems.

In two projects, a team approach became necessary because of the varied quality of the lessons or the distribution of talent within the authoring staff. Both teams produced adequate lessons within the allotted time. Factors contributing to this success were the prespecification of procedures, experienced management, and the decision to limit the instructional strategies. A disadvantage of the team approach in one incident was the disproportionate amounts of work by the members.

Individual authors had a personal investment in their lessons. They were often defensive about them and reluctant to accept advice or make revisions. Use of the team approach reduced this problem since each person's "stake" and involvement in the lesson was not so great.

1. Lesson designer with programmer assistant

Case 3C1.1 - Programmers too creative (1)

A project head was a content expert and university instructor. He learned the TUTOR language, but felt that his time could be more profitably spent if he designed the lessons and hired a programmer to code them. However, the programmers were carried away with personal creativity and felt compelled to contribute to the lesson. Each of the programmers hired created lessons which were not as intended or specified by the designer. Sometimes they "embellished" the lesson with graphics and animations that were fun to create.The problem was that they did not improve the lesson. In fact, the students became frustrated when they had to wait the few seconds until the end of the graphics before they could proceed with the lesson. Sometimes the programmer changed the presentation slightly but the total effect was different from that intended and the lesson was apt to be unuseable.

Case 3C1.2 - Programmers too creative (2)

The director of a large curriculum project hired staff members who were experienced teachers and/or lesson

designers. But many of them felt that their programming skills were insufficient to implement their ideas. So the director hired programmers with no teaching experience. These programmers tended to be too creative by writing lessons that did not conform to the directives of the lesson designers. The resulting lessons frequently missed the teaching objectives and/or the intended level of difficulty.

Case 3C1.3 - Graduate student programmers: scheduling bottlenecks

One curriculum development group hired graduate students as programmers. Sometimes this proved to be a bottleneck in lesson production. They scheduled their programming duties around their courses and studying needs, which meant they often planned to program at night or on weekends. However, at those times the system was sometimes down. Furthermore, senior staff were not available to serve as consultants. The students who were on assistantships were entitled to all university vacations. This presented a particularly big problem when the vacation was a month long break between semesters.

2. Instructor with programmers

Case 3C2.1 - Inadequate guidance

An administrator picked particular courses in his department for development of CBE materials. He asked each instructor who was a content expert to be in charge of his own subject matter. A programmer was assigned to each professor to carry out the project. The lessons were variable in quality. If the professor provided guidance in instructional design or if the coder had teaching experience, the lessons were good. However, some professors just turned over content information, and programmers wrote ineffective lessons.

Case 3C2.2 - Absentee lesson designers

A professor who was interested in using CBE, but who did not have time to become acquainted with the medium, hired a programmer to develop lessons for him. In the course of a year, the programmer (a graduate student in the subject area) acquired an understanding of appropriate uses of the medium but was frustrated in attempts to change the direction of the curriculum being produced. His supervisor's only contact with CBE occurred during monthly visits to view the latest materials. Suggestions for design approaches tended both to underutilize the capabilities of

the medium and to make unrealistic demands on the programmer by insisting on specific effects that were very difficult to program (and which were often pedagogically equivalent to effects which were easily programmed).

In another subject area, a professor with past experience in design of individualized instruction initially hired a programmer because he did not want to "waste his time with the details." This professor spent a great deal of time reviewing and modifying the lessons he designed. He found it very frustrating to have to work through an intermediary (particulary since he could see how easily most alterations were performed). Finally, the professor decided that it was much more efficient for him to learn to program directly himself. He ultimately produced many hours of effective instruction for CBE.

3. Independent authors

Case 3C3.1 - Success

In at least three cases new authors were graduate students who had teaching experience and were subject matter experts. Even though they had no programming experience, they were able to learn programming and to write useable lessons. Part of their success may have been due to the fact that their early affiliation with the project was similar to an apprenticeship. They had the consultative support of a project director with expertise in all aspects of authoring. Furthermore he understood that they needed some time to learn by trial and error, particularly in the early phases.

Case 3C3.2 - Shift to hiring programmers

One group began by having each author design as well as program his own lessons. The co-leaders found that they were unable to maintain a perspective of the higher level of organization of the curriculum. So they decided to centralize lesson design and make it the responsibility of just two people. Programmers were hired to carry out the details. The result was more efficient lesson production and generally better products.

Case 3C3.3 - Shift to team

At two sites each author was wholly responsible for a lesson. This responsibility consisted of planning, writing, and coding the lesson. The result was that lessons varied greatly as to instructional approach, physical characteristics, and quality. Also since the authors' experience and

talent varied, some depended on their colleagues for extra help. Thus, for example, one of the authors found himself burdened not only with writing the lessons assigned to him but also with helping colleagues who were having programming difficulties. In one instance, when a senior author left unexpectedly, the project foundered because nobody was available to help the less-experienced authors. Both projects shifted to team approaches in order to make better use of the available talent.

4. Team approaches

Case 3C4.1 - Uniform procedure provided

At one site, the varied quality of lessons produced by independent authors led to the decision to establish a uniform procedure of lesson development. This included not only tasks that were necessary for lesson development in general, such as writing objectives, criterion tests, and peer lesson review, but also procedures for creating instructional strategies and performing formative evaluation.

This decision allowed for and was followed by a formal division of labor. It resulted in more rapid lesson production, and lessons that were relatively uniform with respect to strategies and quality.

Case 3C4.2 - Standards prespecified

At one military site it was felt that the staff available for authoring did not have all of the necesary subject matter expertise for developing lessons. Previous experience at that site, using independent authoring, had resulted in a wide range of lesson quality. Some of the lessons were unnecessarily elaborate for meeting the limited objectives of the program. The decision was made to organize three-member teams, each consisting of a content expert, an instructional designer, and a CBE expert. The administrators also specified standard strategies and techniques, and a lean approach to lesson design. They allowed no new teaching strategies and no use of new hardware. As a result, adequate lessons were produced in the allotted time.

Case 3C4.3 - Preliminary guideline and analysis provided

At one site a system for lesson development was devised by one group of personnel. Authors in the CBE project were required to follow this process, although they were not involved in creating the plan. It was anticipated that CBE lesson development could be speeded up because the initial

guidelines, analysis, and objectives had already been prepared for them. The creativity of the CBE authors was limited by the contraints set by the systems developers. The CBE authors did have the advantage that they did not have to start from scratch in designing lessons. They found, however, that the components of the process were inadequate for preparation of CBE materials. As a result, more detailed outlines of the lesson content were furnished to the authors. In addition, subject matter specialists were brought in to lend their expertise.

Case 3C4.4 - Group brainstorming

One group decided to formulate initial versions of lessons by group "brainstorming sessions." The attempt failed. It was difficult to get authors to implement session suggestions. Authors felt this system jeopardized their autonomy.

## D. Lesson Design

Of the many factors in lesson design that require decisions, three are represented in the cases cited below: (1) the use of standardized vs. free-form lesson designs; (2) the use of minimum standards and guidelines; (3) the degree of pre-planning needed before beginning on-line design.

The goals of the project related closely to the decision about standardization. When the goal was to teach minimum basic skills, (often found in a military environment), the objective was to train the students to a just-adequate level of proficiency. Such lessons put more emphasis on score than on helping a student reach a very high proficiency (Klecka, 1977). Such lessons often used standardized formats and strategies to achieve their goals.

On the other hand, varied techniques constituted an appropriate approach where one of the objectives was to try to determine which strategies were most effective in terms of student performance and acceptance, or when the objective was to provide breadth of experience. Authors of lessons with these goals discarded standard approaches in order to teach students to the fullest extent. Compared to lessons with standardized formats, these lessons varied widely in quality, from truly excellent to essentially useless.

In order to expedite student interaction with peripheral equipment, data collection, and lesson debugging, one project set minimum standards for all lessons. In at least two projects, decisions were made to standardize the programming: certain variables were set aside to hold information that was necessary for overall curriculum

management. When one director of a large project failed to make such plans, the results were chaotic.

The traditional systems approach to lesson design demands complete prespecification of goals and methods. Some authors of PLATO lessons ignored the sytems method and used an artistic approach. They created lessons much as an artist creates a picture. No hard data are available to evaluate the effectiveness and production time required for lessons done this way. Many experimental independent authors, who began with the systems approach, cast this method aside in favor of an evolutionary method. They often found that when they translated their plans to the terminal, many details had to be changed, and the careful planning had been a waste of time. They preferred, instead, to pre-plan only the objectives and content of the lesson. Then they designed the lesson on-line and revised as necessary as the lesson evolved.

1. Varied techniques vs. prespecified strategies

Case 3D1.1 - Varied, good results

One director of a university project decided to try out a variety of pedagogical styles. His goal was to try to determine which aspects of lesson design were most important with respect to student acceptability and performance. He was unable to find any differences. The two things that did affect lesson quality were the availability of "help"s (supplementary explanations that could be obtained on request) and good answer judging. That is, the student wanted to be judged right when his answer was correct. He did not want to be a "mind reader" and try to figure out what form of the answer was acceptable.

Case 3D1.2 - Varied, poor results

In two different situations the decision was made to allow authors complete autonomy in choice of instructional strategies and presentation techniques. Although well versed in the subject matter, the authors were relative novices in the areas of TUTOR programming and instructional design. In one of these two cases, goals were not clearly specified. The resulting lessons in both cases varied widely in quality as well as in style.

2. Standards and guidelines

Case 3D2.1 - Standards

In an early phase of a large curriculum development project, a considerable amount of time was spent designing

individual lessons and refining them rather than trying to do the whole curriculum. These were carefully student-tested for specific successes and failures. In this way a set of basic standards was developed. The original lessons, along with the standards, served as a model for subsequent lesson development. A considerable number of the paradigms were later used repeatedly with different content matter.

Case 3D2.2 - Standardization

Several groups decided to reserve specific variables to hold specific information. Later when decisions were made to implement changes in curriculum management, the lessons themselves did not have to be revised. The director of another project found that his independent authors used different terminal function keys for different purposes. The students were needlessly confused. He decided on some standard uses, and all lessons were revised to meet these requirements. This greatly improved the ease of student interaction. Later he prepared standard initial displays which authors could easily attach to new lessons.

Case 3D2.3 - No standards

The director of one large curriculum project made no decision about lesson standards or models. Each author wrote lessons independently of the others and made little attempt to coordinate efforts or standardize lessons. The result was a fragmented set of lessons of variable quality. The totality of the lessons met no particular goals or objectives and it was difficult to evaluate their effectiveness.

Epilog. The director decided to divide the authors into groups, each of which was responsible for specific topics in the curriculum. Subsequently, each group developed its own goals, procedures, and standards. Each group's lessons were a more complete and cohesive whole and could be evaluated.

Case 3D2.4 - Pacing

In one subject area, the students began to expect a certain, fast-moving pace of interaction with the terminal. If a problem was difficult and required more than 3-5 minutes of thinking before any answer could be arrived at, the student was likely to complain, and write a note on-line to the author in a file provided especially for student notes. The author decided to provide help for questions which the students found difficult. As a result, there were almost no complaints about problem difficulty.

Case 3D2.5 - Incomplete use of the lean approach

One project adopted both a "lean approach" and mastery learning approach to lesson design. The chief curriculum designer decided to teach only what was necessary, since the goal was to produce qualified individuals at a minimum cost. However, rather than modify the lessons where student usage showed the original content to be inadequate, the original lesson was retained and students were routed through it repeatedly until they passed the performance test. As a result, the lessons provided little branching for remediation help and little corrective feedback information. If a student failed the criterion test, he had to repeat material he had already done successfully in order to get to parts he had failed. This was abrasive to students and made inefficient use of their time, but it was more efficient in terms of authoring time. The author did not have to create additional material for help units or program branching alternatives. This lesson design philosophy had one other disadvantage. The authors did not explore alternative lesson formats which might have taken longer to develop initially but which could have reduced training time needed.

3. Procedures

Case 3D3.1 - Experienced author, shift from systems approach

One director initially used a systems approach to lesson design. He found that when he put the lesson on-line, it turned out quite differently than he had anticipated. For example, the screen display was too crowded and the essential idea was lost. He decided to do only a minimum of pre-planning. He only planned the topics that would be covered and the objectives of the lesson. All of the rest of the lesson design was done on-line. This proved to be most efficient because the author could look at the small sections immediately and revise as he went along. Moreover, new ideas were spontaneously generated in the process of iteration. It should be pointed out, however, that this author was very experienced in using the CBE system as an instructional medium as well as in his subject matter and in teaching.

Case 3D3.2 - Experienced author, shift from detailed planning

One director-author began developing lessons by writing down all details. After completing 2 or 3 lessons (about 45-minute instructional sequences), he realized that parts of them had to be rewritten. After that he decided not to

preplan large sections, but to design small sections at a time and proceed as in Case 3D3.1 above.

## E. Peripherals

Peripheral equipment added new capabilities to PLATO terminals, but also brought complications. It was not always immediately available and experienced users were few. For example, touch panels arrived slowly, and it was often the case that a touch panel was not available for every PLATO terminal. The directors had to decide whether or not to program lessons to include the touch capability. In three cases, the authors decided not to use touch until all of the equipment was available. Since delivery was very late, most lessons did not include touch. The director of another project included touch in the lessons, but held up student trials until all of the needed panels became available. A successful alternative to the dilemma was the use of a touch simulation until panels were available.

In many subjects, teaching is greatly enhanced by the capability of superimposing terminal-generated characters on slides. In order to implement this technique microfiche had to be produced. PLATO production was not a quick or easy process. The attempt to shortcut this process led to disaster.

The audio device was still in a prototype stage when one project director made a commitment to use it extensively. Much of his staff's time was devoted to testing it and making it easily available. This greatly decreased the time the staff could spend on lesson development. Other project leaders decided not to use audio because trial lessons demostrated it was poor quality and unreliable.

### 1. Touch panels

Case 3E1.1 - Not used until available

In at least four cases touch panels arrived slowly. Not all terminals had panels when the authors were planning and developing lessons. If they decided to incorporate touch, the lessons could not be used on some terminals. If they did not use touch, this nice feature would not be in the lessons even when panels were available later. At three sites, the director decided not to use touch input until all panels had arrived. Consequently few lessons incorporated this feature. At another site, the touch panel was included where appropriate. However, there were no student trials of any lessons until touch panels were available.

Case 3E1.2 - Successful alternative

In at least three projects, programmers were unable to test their touch programs for lack of available equipment during regular working hours. Thus they had to work during non-prime time when systems maintenance resulted in frequent interruptions. An alternative plan used by one group was touch simulation. Touch was incorporated where appropriate and lessons could be used even without touch until the panels arrived.

2. Microfiche

Case 3E2.1 - Shortcuts didn't work

Francis (1976) has provided a detailed account of the difficulties encountered in the production of microfiche. One decision that always ended in disaster was the attempt to expedite production by shortcuts of one sort or another.

3. Audio

Case 3E3.1 - Time constraints

The director of a project committed himself to use of audio when it was in an early prototype stage. It was to be an essential part of instruction. In order to insure availablility of the audio equipment in sufficiently reliable form, much of the group's time was spent testing hardware and providing service software so the audio could be used easily. This severely limited time available for needed course development work and for field testing of materials. Late delivery of hardware also limited access of students to the material. Total productivity for the group in terms of hours of instructional material per hour of time expended was over 2000hr/hr.

Audio disks could not be reproduced fast enough to meet the needs of all users. Lessons could not be used without the audio. The intended population was dismayed. Also, slow reproduction siphoned off staff time and limited the number of lessons that could be produced at a much needed higher cognitive level.

Case 3E3.2 - Conscious decision not to use audio

At least four project directors felt that an audio device would be very desirable for their CBE lessons. In some cases their students were poor readers. In others, sound such as a human heartbeat, was an essential part of instruction. They wrote mini-lessons to test out the

quality and reliability of the audio device of the CBE system. They found the sound was poor quality, partly due to excessive background noise. The audio was also unreliable: sometimes messages were wrong and occasionally they simply did not occur. Consequently the directors decided not to develop lessons that depended on that audio device.

Case 3E3.3 - Dabbling

In several instances, authors "dabbled" with peripheral equipment. For example, they included microfiche in just one place, or touch responses in a few displays. They mistakenly thought they were only supposed to use these peripherals when absolutely essential. For example, they were to use the touch only in instances where it would be very difficult to have the student make his response by pressing a key. In every case, the results were bad. The author did not take enough time to understand how to use the peripheral device effectively. Consequently, the affected parts of the lesson did not work properly.

F. Implementation and integration of CBE

It was not the case that PLATO lessons were automatically integrated into existing programs. Characteristics of successful integration were: (1) lessons were easy for the instructors to use; (2) information about student progress was provided; (3) instructors' requests were given careful attention and consideration even though they could not always be met; and (4) a proctor was available in the classroom. Integration with traditional instruction was facilitated when the instructors were involved some way.

Major difficulties included instructor resistance to CBE and resistance to using somebody else's lessons. University students resisted doing the lessons when they did not consider them to be a regular part of instruction, like lectures and laboratories. Some techniques that helped alleviate the problem were: (1) scheduling PLATO sessions in the time table; (2) giving extra points for completing lessons; and (3) including some questions from PLATO lessons on the hourly tests. Students also objected when the terminals were far from their usual classroom buildings.

In some institutions, one classroom of terminals was available for many classes in many disciplines. Scheduling problems were particularly difficult when terminals were assigned for evenly-distributed use by each class but the lessons required concentrated, day-after-day usage.

1. Factors that contributed to successful implementation

Case 3F1.1 - Make it easy for the instructor to use

The initial plan in one project was to give the teachers control over sequencing lessons. The hope was that this would encourage them to integrate the CBE lessons with the rest of their teaching in this subject. However this involved a fair amount of attention to detail on the part of the teachers and was not easy to implement. In another project, the director developed a considerable body of lessons for his discipline and was eager for others to use them, too. He made it easy and convenient to use the lessons, even including on-line tests (although they were not called tests). The more convenient he made it, the greater was the general acceptance.

Case 3F1.2 - Inform the instructors about student progress

In some cases, CBE terminals were part of the classroom equipment. Some students did CBE lessons while others were engaged in different activities. The instructor was too busy to observe the students when they were using the CBE lessons. Yet they wanted to know how their students were doing. Initially the project director decided to provide on-line information about how each student was progressing, and in great detail. However, there was too much for the instructor to read and too much data for him to get a general idea of how the students were doing. The instructor simply did not use the detailed information when it was available only in this form. In this project, CBE lessons were just one aspect of classroom instruction. The project director decided to make two changes. (1) Data made available to the instructors was very simple and referred only to key lessons. Usually all of it could be presented in one screen display. (2) A printed copy of the data was made and given to the instructor. The result was that they were able to tell very quickly how well the students were doing. If they did not have time to look at the data on-line, they could and did take the printed copy home with them and look at it at their convenience.

Case 3F1.3 - Listen to instructors

In two large curriculum projects decisions about the lesson content were made at the development center. In the early phases, instructors were not overly enthusiastic about CBE. Those who used the materials frequently made requests for different or additional lessons as well as particular kinds of information. The authoring staff was often not

able to meet most of these requests. However, when the staff took the time to listen to the instructors and talk to them, the instructors' attitudes improved.

Case 3F1.4 - Lead time for instructors

Elementary school teachers were very busy during the school year and did not sign on to the terminal very often. Therefore they did not see many of the lessons that were developed during the year. Nor did they gain the "comfort" or feeling of ease with the machine that comes from interacting with it. The teacher's attitudes toward CBE instruction improved with his degree of comfort, and his attitude was reflected in the students. When possible, time was provided during the summer for teachers to review the materials and experience working as a student. The result was that they were more at ease using the CBE system and more likely to treat the lessons as an integral part of the class. Students then picked up this attitude and took the CBE lessons seriously.

Case 3F1.5 - Proctor available in classroom

One project provided a classroom proctor and also an on-line file in which students could write comments. One of the factors that contributed to the director's decision to keep a proctor on duty was that the students had "better feelings" when a person was around. In fact, the tone of the comments in the note files was much milder when they could talk about their comments to a proctor.

Another project began to use CBE lessons for regular classes before the lessons were carefully revised. The director decided to have proctors in the classroom to help the students over known problem spots in these lessons. Thus they could use otherwise unuseable lessons until authors had a chance to fix them.

Epilog. After several semesters of experience and considerable lesson revision, they decided to retain a proctor in the classroom. During the first two weeks of the course this was necessary to take care of various beginning of semester problems. After that, the proctor was available to help students with related, non-CBE difficulties, as well as to write notes to the authors about pertinent observations. He also encouraged students to put notes in the comments file.

Case 3F1.6 - Show the student his progress

A curriculum project implemented a mastery learning strategy in one section. That is, the student had to

achieve a preset criterion in order to move on to the next level of difficulty. Initially, the student's progress was shown only to the instructor and not to the student. The students thought they were moved from one lesson to another by some sort of magic. Motivation was poor. The decision was made to show the student his progress and to explain why he was moving ahead or repeating a section. This approach resulted in better motivation, and increased instructional progress.

2. Factors for successful integration

Case 3F2.1 - Printed copies of lessons

The lesson developers in one project were eager to have the teachers integrate PLATO lessons with regular classroom lessons. In order to encourage this, CBE personnel made worksheets that corresponded to the PLATO lessons, often getting electrostatic prints of terminal displays and reproducing them for the entire class. This had many benefits. It enabled the teacher to observe the children if the whole class was working on the worksheets at the same time. Alternatively, he could look at their work after they handed in the papers. Otherwise, he might not have much opportunity to observe them studying the lesson because, for the most part, he was occupied with the rest of the class when any four children were taking their turn at the CBE terminals. Also the teacher could take the printed copies home and look at the lessons at his own convenience. The children liked the idea of worksheets related to their PLATO instruction.

Case 3F2.2 - Involve instructors

Early in the development of each of three curriculum projects, lessons were written at the development center and brought to the participating institution. Students took the lessons in a special classroom. The instructors had previously attended some orientation meetings, but were nevertheless disinterested in the CBE program. Later in the project, the decision was made to consult the instructors before lessons were written with the objective of coordinating them with standard classroom materials and methods. The result was interest and cooperation from the instructors. The students' attitudes changed from regarding CBE as an "extra" to considering it an integral part of their studies.

Case 3F2.3 - Instructor control

One project director organized his curriculum in a tree-like hierarchical organization. He developed a computer router which automatically made all decisions about the "optimal" next lesson in the hierarchy. Unfortunately, the pedagogical needs of the students were different in each skill area and the generalized decision making scheme did not meet all of these needs.

Epilog. The decision was made to change the locus of control. Management control was transferred to the instructors, who set up a daily list of lessons for each student. The results were as good as or better than those under the automated system.

3. Implementation problems

Case 3F3.1 - Not enough terminals

In one institution many different courses offered CBE lessons, but there were not enough terminals. The decision was made to allow each student one hour per week, during class time if possible. In one discipline, some of the lessons were intended to be used in five or six consecutive sessions. Once a week was not effective and the students could not get the impact that was intended.

Case 3F3.2 - Resistance to using somebody else's lessons

In one discipline, CBE lessons were prepared on topics that were part of the standard instruction in the beginning courses. These courses varied slightly according to whether they were intended for majors or as a service for students from other departments. The department head made the decision that the CBE lessons should be used to replace lectures on those topics. Instructors showed different reactions. One instructor who taught "majors" resisted using the CBE lessons. He claimed the lessons were too easy. Another instructor suggested that this was an excuse, and the real problem was that the individual was near retirement and a victim of inertia. An instructor who taught a service course for graduate students used the CBE lessons to replace lectures. He complained that the students did not get enough out of the lessons because they were not tied to the homework. Instructors who taught a large service course accepted the CBE lessons and used them to replace one of the two weekly lectures throughout the course. They considered the lessons quite acceptable because there was no decrement in student performance.

Case 3F3.3 - Resistance to CBE

One group of individuals in a university department developed CBE lessons and made them available to all members of the department. The older staff who were near retirement professed an interest, but never found the time to look at the lessons. They refused to have anything to do with the lessons as part of their courses. They did not even try the lessons or observe students doing them. It is possible that these people were simply not interested in any innovations, but it is just as likely that they were wary of computers and CBE in particular.

Case 3F3.4 - Increasing student attendance

In several projects, some students did not consider CBE lessons to be a "regular" part of the course. Others found the classroom of terminals was not conveniently located. The instructors found too many students were not trying the lessons. One project director decided to give two extra points toward the semester grade for each lesson the student completed. Another instructor announced that some of the hour exam questions would be taken from information given in the CBE lessons. Both methods were successful in increasing student attendance.

Case 3F3.5 - Administrative dilemma, games

One of the administrative decisions that had to be made was whether or not to allow game playing at a site. One problem, seen fairly often, had to do with "PLATO drop-outs"--students who became game freaks at the expense of their studies. Another consideration was the adequacy of resources for both regular lessons and game playing. In at least two university terminal classrooms the site director organized a list of games for students to be able to access. The top administrators made different decisions in the two cases.

In one case, the site director set up a list of games to make the PLATO system more appealing. The project director decided that this was a poor policy and discontinued game playing. He felt it would encourage students to think of the PLATO system as a source of games and not as a serious instructional device. He also felt that some of the students who were being attracted to the classroom were not part of the target population. Their presence was certainly not good advertising for the project director who was trying to justify the advantages of CBE.

In another case, the site director felt that games enabled students to get a refreshing change of pace from

intensive study. Terminal usage was completely restricted so problems with outsiders never arose. The top administrators did not object to the availability of games, and no serious problems were reported.

# Chapter 4

## EVALUATION

Formative evaluation, that is, evaluation during lesson development, early became a necessary part of the process of lesson development. In fact, in most projects continuous evaluation was an integral part of lesson production, implementation and maintenance. Edwards and his colleagues (1975) have suggested that at least four kinds of changes take place as a program evolves. They argued that evaluation should be continuous because these changes are continuous. The changes that occur in the development of a PLATO lesson closely parallel those that they enumerated. (1) The objectives of the project sometimes changed, as from research to applications orientation. (2) The program changed in character, such as from being self-contained to being an integrated part of a larger whole. (3) The program was established in response to some educational or societal circumstances, and those changed. For example, initial plans for an innovative curriculum were dropped for lack of funds or changing interests. (4) Knowledge accumulated and dictated changes. This was true of all aspects of PLATO projects.

It was important for each PLATO project to have an evaluator as a staff member or as a consultant. In one incident, where there was no one person in charge of data keeping, overlapping responsibilities and an inadvertent breakdown in communications resulted in a considerable loss of data. When an evaluator was not consulted, inappropriate statistical techniques were employed and the results were difficult to interpret and generally questionable.

Planning appropriate formative and summative evaluation during the initial stages of project development was essential. By making such plans, one project was able to evaluate the effectiveness of what was accomplished even though they did not meet all of their goals. In contrast, another group did not plan for evaluation and also did not meet its goals. As a result they could not even evaluate the lessons they did complete.

In general, data were used not only to assess effectiveness but also to revise and improve lessons. Formative evaluation included lesson reviews, student trials, and lesson validation. The impact of lesson reviews on revision depended on the timing of the review, the qualifications of the reviewer and the nature of author-reviewer relationship. End-of-lesson reviews by the outside consulting staff effected few substantive revisions.

This lack of acceptance was surmised to be due to three psychological factors (Call-Himwich, 1977). (1) Authors were subjectively involved and viewed their lessons in much the same way an artist views his work. (2) By the time an author received the review he had already begun work on a new lesson and was deeply involved in it. The old lesson was "cold" and had been tucked away mentally as "finished." (3) The totality of so many suggested revisions may have been overwhelming.

Reviews made during lesson development increased the probability that lesson revisions would be more than cosmetic. Experienced teachers and colleagues who were also authors were usually effective reviewers. Subject matter experts tended to look only at content accuracy. It was felt that university-oriented reviewers made inappropriate suggestions because they did not understand the environment or needs of the non-university student. Face-to-face interactive reviews between author and reviewer seemed to be more effective than written reviews.

Student trials were important for both lesson revision and validation. Collection of on-line data, such as time and record of responses, enabled the author to revise the lesson to fit the allotted time and to detect problem areas. It was necessary for authors to observe student trials in order to note trouble spots which on-line data did not reveal. Reliable information was most likely to result when the students who tried out the lessons were from the intended student population. One project made specific plans to validate lessons and this validation helped smooth implementation. Failure of other groups to validate resulted in some unuseable lessons and many frustrated students.

At least four project directors established notes files and encouraged students to make on-line comments about lessons. One director said they were valuable but three directors said the comments provided little useable information and sometimes they were in bad taste.

In at least four projects, the student could request on-line information about his status and progress. This was particularly motivating and saved a great deal of instructors' time. In one project which did not make such information available, a major complaint from the students was that they did not know where they stood in the course.

Lesson effectiveness was measured in different ways. Some projects compared test scores and/or learning time with a control group. Others did pre-test, post-test comparisons to determine gains. Most projects used some form of opinion questionnaire. No specific cases are cited below, but it was generally felt that these questionnaires provided the project director with useful insights about the students'

attitudes toward a particular lesson or the entire CBE course.

## A. Planning Evaluation

### 1. Need person in charge of data

#### Case 4A1.1 - Loss of data

Evaluation of lesson effectiveness was a major goal of one project. The staff did not include an evaluation specialist. One objective was to compare CBE lessons to non-CBE. Students in both CBE and control groups were required to take a paper-and-pencil quiz at the end of each topic and to meet a specified performance criterion. If the student passed, he received a "pass" rating and was allowed to continue on. If he failed, he received a "fail" rating and had to repeat the lesson and quiz cycle again until he passed. The pass/fail data had been chosen as one measure of lesson effectiveness. The other measure was the total time it took the student to successfully complete the lesson.

Time data for CBE students were automatically collected by the computer and transferred to permanent storage for later use. Times for control students were recorded by the instructors and later entered into a computer file. All of the pass/fail data was to have been entered into a computer file but the computer program was not available in time. Therefore the course personnel recorded each student's data as he progressed and later collected all the data. They informed the CBE staff that they would keep it indefinitely or let them know if it was to be destroyed. However, when the CBE staff requested the data, they found that some of the data had been inadvertently destroyed. Unfortunately, not all of the original data was recoverable. This loss could have been prevented if the responsibility for data keeping had been assigned to a single individual.

Plans for statistical analyses of data were made without consulting a specialist. The most appropriate statistical tests were not chosen, and the results were not as reliable as they could have been.

#### Case 4A1.2 - The need for experienced evaluator

At one site, there was no experienced evaluator on the staff. However, staff members patiently collected quite a lot of data before they started analyzing them. A cursory glance at the data showed that they had been crudely gathered (by non-project staff). After improvements to the data gathering, it was found that non-CBE instructors felt

that the evaluation data being gathered could be unfavorable toward slow students. So the staff members were lenient toward them and gave them "breaks" to make them look better. Experienced evaluators would have begun analyzing data immediately as well as devising tests and checks for the validity of the data.

2. Need to pre-plan evaluation

Case 4A2.1 - Rewards of planning

One director selected the target course for CBE and set up the hypotheses he would test even before authors were trained. As a result, project development moved steadily toward testing the specified goals. Although some of his data were marginal in value, the director was able to provide some useful evaluation.

Case 4A2.2 - Shift to formal evaluation plans

A site had the responsibility of developing instructional materials for a large portion of a course. Either because of the press of daily events or because of a conscious decision, no formal formative evaluation program for the lessons being developed was instituted. Some lessons were tried out in trial student runs, but these trial runs were haphazard at best. Peer lesson reviews were recommended but were by no means universal. The only constant in the formative evaluation of these lessons was the outside reviews which were done several times for most lessons. This service combined with site peer reviews was mistakenly presumed to be as good as thorough student testing of the lessons. When real students began using the lessons, several gross errors appeared in them, causing a great loss of confidence on the part of the students. This loss of confidence was surely a factor in the eventual failure of the project. Second, the authors were forced to revise lessons as the students revealed errors in them rather than develop lessons for the next segment of instruction. This had the effect of putting the staff even farther behind in an already heavy schedule.

Epilog. At a later time when the project was again reorganized, a formal plan for evaluation was written and the necessary data were collected. Though not perfect, they seemed adequate.

Case 4A2.3 - Failure to plan evaluation

At one site, no evaluation plans were written initially. Consequently, as the project progressed, plans

had to be written and rewritten several times due to the lack of agreement between various staff members who were responsible. Every time new plans were developed, a considerable number of lessons were discarded, because they did not fit the newly devised plan.

B. Aspects of Formative Evaluation

1. Lesson reviews

Case 4B1.1 - Timing

In one instance, a consulting and support staff wrote lesson reviews after the lessons were completed. The reviews were submitted in writing and delivered to the author one to two months after the lessons were completed. The reviews covered all aspects of the lesson, instructional and programming quality. Although the authors said the reviews were helpful, authors made only minor changes, such as correcting misspellings. Although in one case a review noted a programming error which would halt student progress through the lesson, the author took no action.

Epilog. Realizing the motivational and psychological drawbacks to receiving an exhaustive critique long after the lesson was "completed", the staff experimented with various alternative review approaches. They finally developed a plan by which lessons were critiqued in-progress, or as they were actually being written. Reviews were shorter, fewer changes were suggested at one time, and major problems could be dealt with before they became chronic. In addition, a new feature allowed reviewers and authors to go through lessons "together," each seeing the same screen display even though they were miles apart. Reviews thus became more an exchange of ideas than the monologues they had once been. Authors responded much more favorably and incorporated 50%-75% of all suggested changes.

Case 4B1.2 - Reviewer credibility

One individual from the supporting institution reviewed lessons of some authors before he had met them. He found that these authors were not as receptive to suggestions as was the case when he had met the author at some time previous to that of the review. Several reviewers found that they were more effective when they reviewed the lesson in the author's own environment. The reviewers also reported that they were more " sympathetic" with the author's problems after they made a site visit.

Case 4B1.3 - Reviewers lack experience with target students

In three cases, the consulting staff were university people. The authors rejected the consultants' suggestions becase they felt that their students were very different from university students. Consequently the criticisms and recommendations were not considered applicable. However the reviewers noted that many of their suggestions were like those stated in more general instructional guidelines at the authors' institutions. The reviewers perceived that the authors were simply using these arguments as an excuse for not accepting the recommendations.

Case 4B1.4 - Reviews by subject matter experts or peers

The organization of information that would be reasonable for a content expert may be quite different from that which would be presented to a novice (cf. Glaser & Resnick, 1972). Peer reviews were important, but could not replace student trials for information value. Peer lesson reviews were sometimes only content specific if peers were not actively involved in CBE.

Some project authors did not like to make the lesson design changes suggested by subject matter and other reviewers. Changes took time and they felt that if the content was correct, the lesson was good enough. Issues in lesson design were regarded as a matter of author whim and unimportant for learning. They therefore requested that reviews be limited to content only and disregarded any design comments made. As a result many reviewers looked at only one lesson and refused to do more.

Case 4B1.5 - Teachers, author-colleagues

In many projects, authors who worked together reviewed each other's lessons in an informal setting during development. Although there was some defensiveness among new authors, experienced authors found these reviews helpful and sought them from respected colleagues. In the elementary situation, teachers sometimes added perceptive insights for lesson revision.

2. Student trials

Case 4B2.1 - Pre-plans to validate

At one site the decision was made during initial planning that there would be a specific number of trials per lesson and a given number of students per trial. The result was a rather smooth implementation. At one site, parallel

lessons were written for CBE and for non-CBE media. Plans were made to validate non-CBE materials before transferring them to CBE.

Case 4B2.2 - No validation

One group needed a fixed number of hours of lessons. The project director did not make any plans for student trials or validation. Students authored the lessons and did not have the time or experience to test them adequately with other students before classes were to use the lessons. The result was that many students in the class were frustrated. They could not always complete the lesson because of programming errors, inadequate answer judging, poor explanations, etc.

Case 4B2.3 - To interpret data

Data collection is an important part of CBE lesson writing. In one group, developers found that some of the data seemed unreasonable, so they decided to monitor the classroom whenever possible. As a result they found explanations of data which they previously could not understand or interpret. For example, one student did the work for another, or a long time delay was the result of a conversation with others around him.

Case 4B2.4 - Authors didn't observe student trials

At one site, authors had been told that they should observe during student trials, but refrain from helping the students unless drastic errors occurred. They were also informed that it is very difficult for an author to stand by when the students struggle with his lesson. Some staff member therefore decided to bar authors during trials! The only information that the authors received was second-hand and abbreviated, of course. Consequently they failed to learn quickly from student trials.

Case 4B2.5 - Inappropriate students

In one case students from another course were used. This was not a required course for them, and they did not feel responsible for learning the content, so they had a casual attitude toward the lessons. The authors assumed that the lessons would be satisfactory for the target students and did not revise the lessons as they should have. When the intended students took the lessons, they saw them very differently. They could not learn the material readily and were very upset.

Case 4B2.6 - Students' comments

In one project, questionnaires were handed out to the students to help the authors evaluate the lessons. Students checked off attitudes on a 5-point scale. The authors found that in some cases, a lesson might get high ratings from students. But when they observed the students in the classroom they had difficulties in a few places. The director decided to add a note file, and urged students to leave comments about specific problems they encountered. The authors found these were extremely valuable for revising trouble spots. Lessons could thus be brought to a highly polished form.

Two other projects decided to use note files because they were interested in student reactions. Neither one of them found the notes particularly useful for lesson revision. Some comments were in poor taste. The director of yet another project decided that notes would be useful. He anticipated that if many notes were sent from a particular place in the lesson, it would indicate that it was a point of high frustration. However, the notes were too general to be of value in revising lessons. They were frequently derisive and discussed the instructor or the CBE system. One condition common to several courses whose notefiles became personally vitriolic, rather than instructionally oriented, was that in these notefiles students were permitted to read and respond to other students' notes. Some instructors found it useful to provide a separate place for comments which were unrelated to the lessons.

3. Shift in procedure

Case 4B3.1 - Shortcut evaluation procedure

In three different situations, the author-director went through the following steps as part of formative evaluation (with revisions as necessary): review by colleagues, trial with a few students, trial with small classes, and finally actual use with large classes. As authors became more confident in their skill at lesson production, they decided that the middle steps were not providing enough additional information relative to the time invested. Eventually they decided to have a colleague review for content errors and then put the lesson out for regular class use.

The above sequence seemed to be a common element of the development of design skills in a specific subject-matter area for a fixed target population. It was frequently reported by experienced CBE authors in interviews. The main danger was that the person assumed that skills learned in these specific circumstances apply universally. For

example, an attempt to provide types of "personalized" feedback that was found very effective for young children failed completely for adult students who reported that the feedback wasted their time and was "childish".

## C. Summative Data

### 1. Reports to students

#### Case 4C1.1 - Report progress

One university professor supplemented his regular course with CBE lessons. He found that most of the students who made appointments to see him just wanted to know how they were doing in the course. He decided to add an on-line capability that enabled each student to see his own records, how he had done on all lessons and tests, and how he compared to the rest of the class. The result was a dramatic drop in the number of students who came to see him during office hours and increased reports of satisfaction with the course.

#### Case 4C1.2 - Failure to report status

One project developed a new curriculum for CBE but did not include any method of reporting to the students how far they had come or where they stood in the course. This deficiency, not knowing where they were at, was a major complaint of students who protested against being in the CBE sections.

### 2. Measures used or needed

#### Case 4C2.1 - Separating out specific CBE effects

Many groups used final performance scores to compare CBE with control students. This was not a satisfactory measure because CBE effects were confounded with other effects. Consequently some evaluators found significant differences, but many did not. Authors in one group decided to write their own criterion-referenced tests to compare CBE instruction with non-CBE instruction on a set of lessons on a specific topic.

The results showed that students completed almost all of the lessons, but the time they took varied considerably. There were no performance differences between CBE and non-CBE students. However, the authors used specific item information to improve the lessons.

Case 4C2.2 - Evaluation should include information about student levels

One group collected time and performance data on low ability-level students during student trials of their lessons. The same lessons were then tried by a different, higher level student group. Data revealed ceiling effects; the material was too easy for the second group, so the authors decided to upgrade the level of the materials. They tried the lessons on a third student population and failed to achieve successful performance. The authors concluded that the lessons needed revision again to meet the needs of this group.

Case 4C2.3 - Record of time spent in lesson

Many projects kept a record of time students spent in a lesson. It is not clear in which cases it was the result of a conscious decision, and in which the time was kept because it was easy to obtain. The uses of the time data varied. Time spent in lesson provided useful indications of the need for revisions. If students needed more than the allotted time to complete a lesson, the author surmised it was too hard and/or too long. If a student scored poorly on a post-test but had spent considerably less time than average in the lesson, the author assumed that the failure was not the quality of the lesson, but the failure of the student to complete it.

3. Post-tests

Case 4C3.1 - Burden of evaluation

In one case, lessons were written at a curriculum development center. Instructors at the cooperating institution refused to give post-tests claiming it took too much extra time.

Instructors at another institution gave post-tests before students had completed the CBE lessons. Others waited until it was very late in the semester and students were too busy to take them. Result: about 20% of the students took the post-test and this was an inadequate basis for evaluation.

In other cases, instructors or the institution were paid for the work entailed in administering extra tests.

4. Need to monitor data collection

Case 4C4.1 - The need to monitor data collection

At the request of an external evaluator, data were kept on the time students spent in lessons in one project. The

evaluators intended to collect data for a specific class rather than for all of the students who did the lessons. Moreover, they intended to delete the data of those students who dropped out of the class during the year because such subjects would not be availble for posttests. The data gathering program was written and data were collected. No individual was assigned the responsibility for it. After the project was completed, it was discovered that the program was collecting data on all students, and not limited to those in the study. Furthermore, the program for dropping students was deleting students from the end of the list rather than those who had dropped out. If someone had been specifically assigned to monitor the data collection, these errors could have been corrected early in the project.

Case 4C4.2 - Inappropriate tests

An outside evaluator devised test items to measure the achievement of students taking a set of CBE lessons. Authors reviewed the items and found them to be insensitive to the objectives of the lessons. Authors felt that the outsiders were, in fact, lacking familiarity with the CBE system and its impact on the students.

In another project, the CBE instructor agreed to use the final test written by the traditional classroom instructor, for a comparison of media. Forms of the same test had been used for several years, and the CBE instructor assumed that prior tests defined the desired course objectives (which the CBE material had been designed to teach). However, the traditional classroom instructor radically altered both test and objectives at the last minute.

# Chapter 5

# MAINTENANCE

Lessons need to be maintained and classrooms should be monitored even after lessons have been successfully used for many classes. A number of reasons support this contention. (1) Information may need to be updated. (2) New program errors may occur. (3) Better ways of presenting the material may become apparent. (4) On-line data don't tell everything about what students were doing in the classroom. And, finally, (5) characteristics of the target population may change. Critical incidents are not available to support every one of these reasons, but experience is accumulating to suggest that they are quite realistic.

## A. Classroom Management

### 1. Proctors

#### Case 5A1.1 - Smoother implementation

Students in one course were sometimes irritated at particular points in lessons and wrote very negative comments. The director decided to have a proctor available during class time. As a result, students tended to discuss problems with the proctor. Whenever such a proctor was available, the typed comments of students were consistently less negative. In addition, proctors could keep authors posted on new errors which had previously gone undiscovered.

#### Case 5A1.2 - Prevent problems

One professor was short of funds, so he did not hire a proctor for his CBE classroom. As a result, some students signed in under more than one name. Essentially they took away the learning privileges of others. Many terminals needed adjustment for using microfiche. Students needed instruction on how to do this. The professor decided to hire a proctor, at least for the first few weeks of the semester.

#### Case 5A1.3 - Need for skillful classroom proctor

In one case, an unqualified person was in charge of a classroom of CBE terminals. This single classroom was intended to be available to students from many courses. Unfortunately, the classroom was overscheduled. At the beginning of the semester, the number of students exceeded

the number of terminals. Instead of explaining the problem to the students and attempting to make some other arrangements, the classroom manager was rude and antagonistic. As a result, many students simply refused to return to use the terminals, even when the scheduling problem was solved.

Case 5A1.4 - Shifting role of proctor

One department decided, on the advice of an evaluator, to have a proctor in the terminal classroom on a regular basis. When lessons were first used for regular classes, some of the lessons were known to have problems, such as inadequate answer judging at specific points. The proctors were able to help students to get through trouble spots and complete the lessons.

After lesson revisions and several semesters of experience, these problem spots were ironed out and the proctors' role after the first few weeks became one of helping students with off-line problems. Other roles of proctors were to write problems, to send notes to lesson authors, and to encourage students to write comments.

# Chapter 6

## SUMMARY

Four major factors that helped PLATO projects succeed were: attention to developing good relations with instructors and administrators, clear goal specification, early plans for lesson validation and evaluation, and plans for contingencies or alterations when circumstances necessitated deviations from initial plans.

Staffing was particularly difficult in the early years, because nobody knew which related qualifications were most important for authors. Almost nobody had had experience in CBE. It turned out that successful authors were people whose qualifications eventually included teaching, instructional design knowledge, content expertise, and knowledge of the TUTOR language. In the early years, new authors had to learn TUTOR without printed handbooks or references, because the system was changing too rapidly to keep printed material up-to-date. They were therefore particularly in need of psychological support from a "master" author or consultant to serve as a model, to help them over specific problems as they arose, and to guide them as to which subset of the TUTOR language to learn first.

There was no single best model of staff organization for PLATO lesson development. Some groups worked as independent authors and others were organized as teams of various sizes. An advantage of the independent author over the teams was that the author did not have the problem of trying to communicate his ideas to another person for implementation; he could execute the lesson exactly as he chose. He could create and revise as he developed the lesson and was not constrained by the necessity of prespecification of details for somebody else. This worked best for authors who were experienced teachers and who became proficient programmers. A disadvantage of independent authoring was the variable quality of lessons that resulted in some cases. Authors became very ego-involved and resisted making changes to improve lessons. The team approach did not engender such ego involvement. Since not all teachers or content experts were proficient programmers, the team approach enabled them to concentrate on content and instructional matters and leave the coding to others. The most successful teams were those in which each member of the team knew something about the other members' domains. A drawback to the team approach was that in cases where a team was put together without clear leadership, internal fighting and power struggles often occurred with resultant loss of productivity.

Formative evaluation was a necessary part of lesson development and served as a basis for lesson revision. Failure to plan for student trials often resulted in gross programming errors, unuseable lessons, and frustrated students. Each kind of evaluation (lesson reviews, student trials, on-line data collection) provided different kinds of information, and one could not serve as a substitute for the other. Lesson validation and data on effectiveness could only be obtained when summative evaluation had been preplanned and necessary data were collected and monitored.

Integration with other instruction required special attention to involvement of instructors in a meaningful way. Classroom implementation required constant monitoring for overall management as well as lesson maintenance.

## GLOSSARY

author: an individual who developed and executed all aspects of a CBE lesson: content, instructional design, display formats, programming.

CBE: computer-based education; instruction delivered by computer.

CERL: Computer-based Education Research Laboratory, headquarters of the University of Illinois PLATO system.

director: the person who was responsible for a CBE project or site.

electronic page turner: a CBE lesson which is essentially like a textbook. It is a succession of displays which provide little or no interaction between the student and the computer.

external source: an institution where lessons were developed, separate from the school which enrolled the target population.

instructor: individual who teaches traditional material and also (possibly) uses CBE lessons. An instructor might also be an author of CBE lessons.

on-site consultant: an individual who was at the same physical location as the author and provided help to overcome programming problems.

signon: an identification given to a person which enables him to work at the CBE terminal.

site: a project at a given geographical location or a project developing curriculum for a particular subject.

TUTOR: the special programming language of the PLATO system.

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